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CONTENTS

CONTRIBUTIONS, ABSTRACTS, AND BIBLIOGRAPHY

† In marine separate.

WEATHER OF THE MONTH

CHARTS

CORRECTIONS

MONTHLY WEATHER REVIEW, July, 1926:

On page 283 the legend accompanying Figure 3 should read "1925" instead of of "1926".

MONTHLY WEATHER REVIEW, August, 1926:

Page 322, middle of first column, in line beginning "corresponding to given values," read: $\left(\frac{\delta u}{\delta h}\right)^2 + \left(\frac{\delta v}{\delta h}\right)^2$

Footnote 2, end of 2nd line, read: ρ_1

Equation (9), first term of second member, read: $a\frac{\delta}{\delta h}\left[E\frac{\delta E}{\delta h}\right]$

Page 323, equation (21), second member, read: $\frac{b}{a}\frac{g}{T_0}\left(\alpha_0 - \alpha_1\right)$

Page 325, equation (43), omit second minus sign from exponent.

Page 330, line following equation (16), read: From (8) and (11).

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WEATHER AND SUGAR CANE IN LOUISIANA

By W. F. McDONALD

[Weather Bureau Office, New Orleans, La.]

(NOTE.—This paper summarizes a much fuller discussion of the subject recently published in *The Planter and Sugar Manufacturer*, New Orleans, La. That discussion gave full tables of data, detailed statistical analyses, and a comprehensive discussion of practical field problems in which weather is a factor, together with numerous graphs. In the present summary, limitations of space prevent the inclusion of certain phases of the original paper, the full text of which may be obtained in pamphlet form on application to the journal named above.)

Sugar cane is a plant of tropical origin and its culture in Louisiana, near the climatic limit of production, is necessarily attended by increased climatic hazards. The fluctuations in weather conditions in this region, therefore, produce a larger effect upon yields, and this relation becomes an important subject of study. Slight tendencies toward persistence of favorable or unfavorable type of weather variations through a period of several years may be sufficient to afford or to destroy the margin of profit from the sugar crop in Louisiana, but these critical variations may be so obscured in the large annual fluctuations that the planters themselves do not become aware of the great influence of the prevailing weather upon their prosperity. However, by statistical analysis of the weather and crop records, the importance of the effects of weather changes upon cane yields are demonstrable.

Sugar cane differs from most other crops in that the desired yield is not produced directly from the harvest but from a manufacturing operation. Yields depend on several factors—tonnage of stalks, sucrose content of the cane, and purity of the juice—each of which is subject to more or less independent variation due to conditions during growth. The nature of sugar, a pure carbohydrate, gives warrant for assuming that besides the usual influence of rainfall and temperature upon the general development of the cane, there should be a large influence of sunshine upon the photosynthetic elaboration of sugar materials.

Data needed for examination of the problem of weather influences upon sugar production required extensive compilation of material. The State averages of precipitation and temperature could not be used, because sugar production is limited to about one-fifth of the area of Louisiana rather highly centralized in its south portion. Average monthly temperatures from three points, and average precipitation from 10 stations, with departures from normal, were computed for the sugar region covering the period from 1890 through 1924. The sunshine record after 1895 from New Orleans, near but to one side of the cane area, was used as the only available measure of that element, but this inadequately represented the true condition over the region as a whole. Some significant results, however, were obtained by using the New Orleans record.

It was necessary to secure the sugar yield records prior to 1911 in order to provide a 35-year series matching the weather records and permitting the use of correlation methods for statistical analysis. Total sugar produced has been recorded for each year, but unless this could be reduced to sugar per acre the data would be of little use in evaluating the weather influences because the total acreage of cane has been quite variable from year to year. From rare sources of information in New Orleans it was possible to construct yield tables showing acreage of cane, tonnage harvested, sugar produced per acre, sucrose content of the cane, and the ratio of sugar to molasses for practically every year from 1888 to 1924. This was the first published tabulation of these varied phases of sugar production in Louisiana for the years prior to 1911, when official Government estimates for the crop begin.

Examination of the records revealed two production periods in the 35 years covered, one for the first half of the series, in which average production of sugar was about 3,000 pounds per acre, followed by a sharp drop to yields averaging around 2,000 pounds per acre in the latter half. Preliminary analysis of the data by simply averaging the weather which marked contrasting groups of high-yield and low-yield years indicated that March temperatures were consistently involved in the differences in yields, as also appeared to be the rainfall of January preceding the crop.

Linear correlation was then applied to all the data. More than 100 monthly coefficients were computed to compare the relative influence of (*a*) monthly rainfall departures, (*b*) monthly temperature departures, and (*c*) monthly sunshine percentages upon (1) the sugar yield per acre, (2) the sucrose content of the harvested crop, and (3) the ratio of molasses to sugar produced. Many of these coefficients were, of course, so small as to lack any significance. On the other hand, four coefficients had a value in excess of ± 0.50 and 25 had values in excess of ± 0.25, many of these lying in groups of two to four adjacent months, with consistent signs. Such grouping appeared to add considerably to the probable significance of these coefficients.

The most significant monthly coefficients were as follows: March temperature correlated with sugar yield per acre gave a value of $+0.53$, which afforded a quantitative measure of the relationship previously found by preliminary graphic analysis. Likewise, the correlation of January rainfall and sugar yield produced a coefficient of -0.51, indicating that a dry January preceding the crop was almost as effective as a warm March in developing high yields. It was a matter of some surprise to find these significant values for weather and crop relations affecting months so far in advance of the season of most vigorous cane growth.

The highest value for this series was found in comparing August rainfall with the sugar content of the cane, this value reaching -0.54, and supported by three ad-

jacent values for June, July, and September, all larger than -0.30. This group of values indicates strongly that a comparatively dry summer season increases the percentage of sugar in the cane. However, since the coefficients for rainfall of the same months against total sugar per acre were of small value, the increase in the percentage of sugar in the stalks due to drier summer weather must be accompanied by a reduction in the tonnage of the cane harvested, a condition favorable to the mill, because such a crop is more profitably handled and manufactured.

The last coefficient of this series with a value of $+0.50$ was found between the molasses/sugar ratio and November sunshine recorded at New Orleans. This value, relating to a month so near the harvest, can only be interpreted as a measure of a large influence of sunshine upon the ripening processes. Detailed investigation of a series of weekly milling results obtained from 13 years' harvests on a modern plantation near New Orleans further emphasized the probability that a decided ripening process usually takes place in November, and that this stage of development is considerably influenced by autumn sunshine.

During examination of the records in connection with the above studies, it was observed that the rainfall departures for the last half of each year were rather persistently below normal in the period when cane yields were high, and generally above normal in the later, low-yield period. This suggested that there might be a cumulative effect of the weather upon the growth and yield of cane. The nature of the cane plant, propagated by nearly continuous growth through vegetative reproduction, seemed to warrant the *a priori* assumption that up to a certain point there is an accumulation of the response of the crop to its environmental influences, especially under persistently favorable or unfavorable conditions, with impressed changes probably carrying forward with more effect because whole stalks bearing the stamp of a given set of conditions are planted and send up shoots for the next crop. Such cumulative effects would not appear in the correlations already discussed, as the lag in response and the longer period involved could not be brought into consideration.

To make an approach to the study of this probable effect upon sugar yields, a graphic method of comparison was devised. This method is an adaptation of the statistical curve known as the "ogive," to which attention as a tool of investigation in meteorological research has been called by Marvin [1], in connection with secular trends in climatic data. As finally adopted here it consisted of comparing *cumulative* rainfall departures for the seven-month period, July through the following January added year by year, with the *cumulative* annual departures of sugar yield and of the molasses/sugar ratio.

The rainfall curve in Figure 1, plotted for the period from 1890 through 1923, revealed remarkable similarity of trend as compared with the yield curves for the years 1891 through 1924, and traceable agreements in minor details further supported the major correspondence. Correlation of the rainfall and sugar yield curves gave the remarkably high coefficient of -0.70, more than eight times the probable error. This was considered a positive demonstration of a large influence of pre-season rainfall upon sugar yields and the general nature of the agreement strongly supported the assumption that the response of the crop to persistent tendencies in seasonal weather is cumulative to an important degree.

The decided trend in seasonal rainfall type, below normal during the first half of the 35 years studied and above normal thereafter, was roughly matched by a similar variation in temperature, revealed especially in the details of a tabulation of frost and freezing dates for 25 years, which indicated that cooler spring and warmer autumn in general marked the later, low-yield period as compared with the earlier period of higher yields.

It was concluded that this cumulative weather/crop relation operates through the seed cane, the more mature cane produced by longer growing season and drier ripening season reflecting its quality in improvement of yields from the succeeding crop. Conversely, late spring frosts shorten the growing season, and if accompanied by warm wet weather in the late summer and during autumn of the same year, the seed cane must be put down while still comparatively green and of low sugar content, this quality tending to reflect itself at once in diminished yield from the next crop. Given a succession of years with similar seasons, accumulation of the favorable or unfavorable response results until the maximum effect of the particular influence is reached. The demonstrated persistences of just such weather

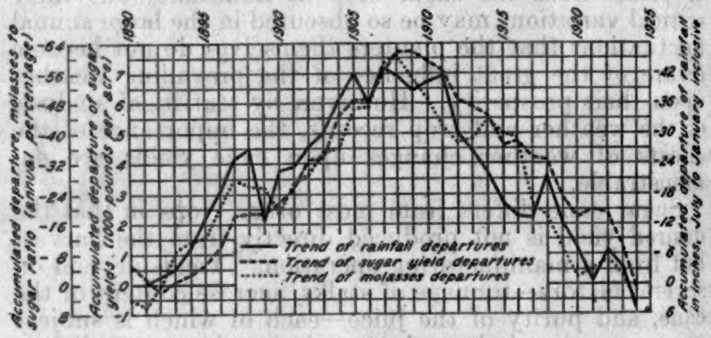

FIG. 1.—Relation of rainfall departures to departures of sugar yield and molasses yield, in southern Louisiana, 1890-1925

conditions are therefore presented as the most logical reason for the great difference in average yields from 1892 to 1908 as compared with the period after that year, ranging from 3,000 pounds per acre in the earlier to only 2,000 pounds per acre in the later period.

The direct influence of the weather upon sugar yields was found to be somewhat obscured by a reverse effect due to the influence of winter rainfall upon the infestation of cane by its principal insect enemy, the cane-borer moth. With 13 years' records of accurately estimated cane losses resultant from borer damage, the remarkably high correlation coefficient of -0.86 (± 0.05) was obtained by comparing these losses (ranging from 9 to 30 per cent annually) with the rainfall departure for the six months from November through April. The size of that coefficient indicates that the rainfall over winter and in spring is a factor responsible for perhaps three-fourths of the fluctuation in cane-borer infestation. Obviously, this influence is directed oppositely to that of the winter rainfall upon cane quality, the insect pest being favored even as the cane crop is favored by drier winter conditions. Elimination of the weather/cane borer effects would therefore raise the value of the coefficients measuring the relation of rainfall to sugar yields.

As a test of the conclusions reached by correlation studies for Louisiana conditions, the rainfall of a number of tropical cane-producing regions was studied, data being assembled for widely separated areas in both the

[1] C. F. Marvin. Concerning Normals, Secular Trends, and Climatic Changes. Monthly Weather Review, 50:383.

northern and the southern hemispheres. These tropical regions were uniformly characterized by distinct wet and dry seasons. It seems reasonable to suppose that the evolutionary responses of cane, a plant of tropical origin, must be closely bound up with the rainfall regimen, seasonally the most variable climatic feature of its native habitat. The relative uniformity of rainfall through the year in the Louisiana cane region is very different from the marked seasonal distribution shown for tropical areas. In Louisiana any variation from normal rainfall tending toward closer approximation to its seasonal character in the tropics is therefore favorable to cane, while that variation is unfavorable which produces or tends toward a uniformity of rainfall.

These considerations support and clarify the meaning of the high correlation found between seasonal rainfall and sugar yield in Louisiana.[2] Those years or terms of years when Louisiana rainfall most closely approximated the seasonal type of the Tropics, with accentuation of wet and dry seasons produced the best yields. In Louisiana increased rainfall during spring until June, and rainfall below normal from August through harvest, produces such an accentuation and increases yields, whereas years or periods of more uniformly wet character, or with the seasonal type reversed, reduce yields.

[2] Tengwall and van der Zyl have found, in Java, a high degree of correlation between seasonal rainfall and the yield of sugar from cane.

THE TROPICAL STORM OF AUGUST 25-26, 1926, IN SOUTHERN LOUISIANA

By R. A. DYKE

[Weather Bureau Office, New Orleans, La.]

This paper, supplementary to the regular report on warnings, New Orleans forecast district, for August, 1926, considers some aspects of the hurricane which have been brought out through further study.

Advance indications of tropical storms are usually provided by the tides and the clouds. As this storm, while in the southern part of the Gulf of Mexico, was apparently small and of moderate intensity, the advance tides were not alarmingly high on the coast. At Burrwood the tide was 0.5 foot above the predicted tide on the 23d and rose slowly during the ensuing 48 hours to a maximum 1 foot above the predicted tide at 11 a. m. of the 25th. Along the coast of Terrebonne Parish slightly higher advance tides were reported, but there are no gage readings for this section.

At Galveston the tide was 2 feet above the predicted tide in the afternoon of the 25th, or 1 foot above the highest reading of the preceding day. This was a local effect, due to the 20 to 30 mile north wind, which favored a moderate accumulation of water in the southern end of Galveston Bay, the escape of water into the Gulf being retarded somewhat by the narrowness of the passes separating the Bay from the Gulf. The moderate southeast swells also tended to increase the tide slightly.

The clouds at middle altitudes, alto-stratus and occasionally alto-cumulus, came from the south at New Orleans nearly all day on the 24th and until 1 p. m. of the 25th, when they became obscured by lower clouds from the southeast and east. During this time the direction of the middle clouds was more changeable at Pensacola and Mobile; both upper and middle clouds were occasionally observed moving from the south and also from southwest, west, and northwest. At Galveston cirrus and cirro-stratus clouds from the south and southeast prevailed during the morning of the 24th, but from westerly directions in the afternoon of the 24th, in agreement with the highest clouds over New Orleans and farther east. In the afternoon of the 25th, when the storm front was advancing to the Louisiana coast, alto-cumulus clouds at Galveston were moving from the north, directly opposite to the movement of middle clouds at New Orleans, as observed up to 1 p. m.

The movement of alto-stratus over eastern Louisiana, considerably in advance of the storm, shows an air current from the south. The northward movement of cirrus clouds over Galveston during the morning of the 24th, and over Port Arthur in the afternoon, appears to have come from the region of the storm, although east of Galveston not many observations of cirrus from the direction of the storm were obtained, the directions indicating a prevailing eastward movement at the cirrus level. The movement of cirrus from southerly directions possibly took place at a lower level than the prevailing cirrus movement from the west. Before the sky became completely overcast with lower clouds, alto-cumuli from the south were noted at Mobile in the early morning of the 25th and alto-stratus clouds from the south at Pensacola in the early afternoon. The width of the northward-moving current was not great and its thickness is unknown; but apparently there was sufficient movement to guide this relatively small hurricane in its advance to southeastern Louisiana.

In approaching the coast the storm was evidently moving north-northeast. Ship Shoal Lighthouse, latitude 28° 54′ 52″ N., longitude 91° 4′ 15″ W., was in the western part of the central calm area at 4 to 5 p. m. of the 25th, with lowest barometer reading (uncorrected) of 28.30 inches, the wind changing through north to west and increasing to hurricane force after the passage of the storm center. Soon after the center passed inland the storm curved to the northwest. The path of the center lay west of the Mississippi River, approaching it rather closely at Donaldsonville and Plaquemine (pressure of 29.16 inches at Plaquemine) and crossing the Atchafalaya River in northwestern Iberville Parish.

Among the influences tending to cause the storm to turn westward in Louisiana we may mention a rise in pressure over Tennessee and northern Alabama and Georgia in the afternoon of the 25th, which, with the relatively high pressure on the west, formed a barometric ridge extending east and west and favored a circulation of air which would tend to drag the storm westward. In an eastward-moving extratropical storm a rise in pressure in front of it has a blocking or retarding effect; in a northward-moving storm the effect appears to be as stated in the present instance, although exceptions may occur when the dominant circulation is not indicated by the surface observations.

The remarkable intensity of the storm, as indicated by the low barometer readings at Houma, compared to those at other stations, was referred to in the preliminary report. The aneroid barometers used at Houma and Morgan City have been tested at New Orleans for readings as low as 28 inches, enabling us to make necessary corrections. The pressure at Houma fell 1.32 inches in 11 hours, at an average rate of 0.12 inch an hour. From 5 p. m. to 9.30 p. m., the rate of fall was 0.32 inch an hour, about the same as that registered at New Orleans in the

larger storm of September 29, 1915. Compared to the average gradient in the 50 miles between Bay St. Louis and New Orleans, in the 1915 storm 0.02 inch per mile, the average gradient between New Orleans and Houma, a distance of 48 miles, in the storm of August, 1926, was 0.023 inch per mile. On August 25, 1926, at 9.30 p. m., there was a difference of 0.66 inch between the barometer readings at Morgan City and Houma, 30 miles apart. As the storm center was slightly west of Houma, we have here a difference of at least 0.66 inch in a distance of less than 30 miles.

After passing Houma the storm decreased in intensity but retained considerable energy until it passed into St. Landry and Evangeline Parishes, where it damaged only crops. Heavy rainfall ceased with the passage of the storm center.

The previous report referred to the lack of high tides west of the center. At some points on the Louisiana coast, notably in the vicinity of Morgan City, the northeast gales on the storm front produced an unusually low tide; the lowest reading of the river gauge at Morgan City was 2.5 feet below zero at 6.45 p. m. of the 25th, about 6 feet below mean low tide. This is very remarkable, for the lowest previous river gauge reading at Morgan City was 0.2 foot above zero.

The Atchafalaya River connects with Grand Lake, a considerable body of water immediately northwest of Morgan City, and with the Gulf to the south, of which the nearest coast line is at right angles to a northeast offshore wind. This wind, blowing with hurricane force, lowered the water along the coast, particularly on the north side of Atchafalaya Bay, where the river empties into the Gulf, and may also have checked the rate of flow from Grand Lake into the river. When the wind backed to northwest, between midnight and 1 a. m. of the 26th, the water in the Gulf, relieved of the unusual strain, began to return to the north and east sides of Atchafalaya Bay, increasing the height of water in the river. A small peninsula, Point au Fer, extends westward from the Terrebonne coast and with westerly gales favors some accumulation of water at the mouth of the Atchafalaya. Simultaneously the northwest gale on Grand Lake increased the flow from that source. The resulting rise of 7.3 feet brought the river back to slightly more than the usual stage in about six hours.

Radiophone broadcasting and reception made possible a better distribution of warnings than in previous storms. In view of the intensity of the hurricane, the large number of people engaged in fishing and other coast industries, and the very slight elevation of the swampy areas in southern Terrebonne Parish, where the storm was most violent, the loss of life, 25 persons, is considered small. Reports of property loss and damage due to the storm are not all in; but trustworthy information indicates that property damage of all kinds, exclusive of crops in the field, was between $3,000,000 and $4,000,000 and that damage to crops will reach an equal or somewhat higher figure.

PERSISTENCE OF WEATHER TYPES IN THE HAWAIIAN ISLANDS

By E. F. LOVERIDGE

[Weather Bureau Office, Honolulu, T. H.]

An inspection of a chart showing mean annual temperatures for a series of years in temperate latitudes does not disclose any tendency to a progressive warming or cooling. On the other hand, in the Tropics this tendency has been frequently noted, particularly by Henry (*1*) and Braak (*2*) for Batavia, Java. In tropical regions the variability of temperature and pressure is very slight, hence any systematic influence affecting these elements, such as sunspots or volcanic acivity, would be much more noticeable in these regions than in temperate latitudes, where variability is great and of accidental or fortuitous nature.

Clough (*3*) has shown by various statistical methods that the sequence of temperature changes from year to year do not follow the laws of chance variations.

In the United States there is a certain amount of persistence of temperature departures from month to month and year to year which is most strongly pronounced in central and southern California. Rainfall and atmospheric pressure do not show as much tendency to persist, but where large areas are taken into consideration there is some tendency of rainfall to persist from month to month during the summer season, at least in some sections.

In order to obtain an idea as to just what tendency there is for one month to be followed by a month of the same temperature sign in the United States, this was computed for 10 representative stations. The percentage of cases ranged from 65 at San Diego to 54 at Salt Lake City. Over eastern United States the result was quite uniform with an average of about 56 per cent, and the tendency toward persistence was greatest during late summer and the least during middle spring, the extreme monthly range averaging 10 per cent.

The persistence tendency probably varies somewhat with the length of record, and with a period of a hundred years or more it can be clearly shown that there is a relation between one month and the same month of the year in the succeeding years. This has been done with the St. Paul, Minn., record covering a period of 105 years, and the result is shown in Table 1. An inspection of this table offers very little encouragement to one who is looking for the effects of periodicities. For example, in the 11-year sunspot period if it were very strong there would be a well-marked positive correlation between months 11 years apart, and a negative correlation between months of about half this period. There is, however, a slight positive correlation shown in the table between months 11 or 12 years apart which is the most noticeable for the winter months.

TABLE 1.—*Percentage of times in which one month has the same temperature sign as the same month of the year during each of the following years up to 16, for St. Paul, Minn.*

Month	First year	Second year	Third year	Fourth year	Fifth year	Sixth year	Seventh year	Eighth year	Ninth year	Tenth year	Eleventh year	Twelfth year	Thirteenth year	Fourteenth year	Fifteenth year.	Sixteenth year
January	51	48	56	50	44	48	58	47	55	55	52	49	59	42	39	44
February	55	50	49	43	47	51	43	53	52	56	59	60	51	49	47	43
March	62	57	57	56	51	46	56	53	59	58	57	54	59	51	42	52
April	53	55	45	46	55	51	59	45	59	47	49	58	51	56	53	52
May	63	49	49	43	52	48	50	53	49	49	47	39	38	46	52	55
June	64	58	47	44	51	47	49	53	51	60	57	58	60	57	59	55
July	59	61	43	56	49	54	54	45	49	43	52	51	53	41	40	49
August	60	52	57	62	61	51	54	51	42	40	40	51	42	36	47	50
September	59	45	50	57	49	46	51	54	43	40	53	59	56	40	51	51
October	50	60	49	52	47	51	46	55	51	53	49	56	51	46	49	53
November	64	59	54	52	55	49	51	48	52	49	50	51	50	48	47	54
December	54	44	47	50	57	48	50	58	41	47	51	47	49	48	52	57
Means	58	53	50	51	52	49	52	51	50	50	51	53	52	47	48	51
Winter means	53	47	51	51	49	49	50	53	49	53	54	52	53	46	46	48
Summer means	61	57	49	54	54	51	52	50	47	48	50	53	52	45	49	51

The most evident relation brought out is the percentage of times in which the month of one year has the same temperatures sign as the same month of the following year. This averages 58 per cent for all months and 61 per cent for the summer months. It would be interesting to determine the effect of length of record on these percentages. Probably they would be less with shorter records as in long records there are well-known long-period oscillations.

At Honolulu, a complete record of temperature goes back to the year 1890, and a record of atmospheric pressure to 1891 with the year 1904 missing. Cox (*4*) has worked out a 10-station average of Hawaiian rainfall beginning with the year 1877 and ending 1921. I have extended this record so as to bring it up to the end of 1925 for the annual amounts and 1924 for the monthly amounts.

It is apparent that these records are too short to show progressive changes unless such changes are well-marked and the variations slight. With Hawaiian temperatures such is the case and the progressive changes are clearly evident; but as rainfall shows a much greater variability, progressive changes, except for a period of a few months which will be shown later, are not in evidence. The same is true of atmospheric pressure and wind velocity.

Applying the ratio $\frac{u}{v}$ to Honolulu temperature in which u is the mean variability, and v the mean deviation, the result is 1.12. The corresponding value is 1.48 for Honolulu pressure and 1.52 for Hawaiian rainfall. The theoretical ratio is 1.414. No progressive change from year to year is shown by this test, therefore, except for temperature.

In Table 2 is shown the percentage of cases in which each month of the year has the same temperature sign as each of the succeeding months up to six, and also of the succeeding twelfth month, for both Honolulu and Tokio, Japan. Being situated on the eastern side of a great continent the climate of Tokio is largely continental, and is comparable with the climate of eastern United States at about the latitude of Virginia as regards both storminess and extremes of temperature.

TABLE 2.—*Percentage of cases in which each month of the year has the same temperature sign as each of the succeeding months up to six, and the succeeding twelfth month, for Honolulu, Hawaii, and Tokio*

Month	Month after													
	Honolulu							Tokio						
	First	Second	Third	Fourth	Fifth	Sixth	Twelfth	First	Second	Third	Fourth	Fifth	Sixth	Twelfth
January	56	52	55	61	52	59	47	48	44	33	55	73	41	38
February	63	69	69	53	56	55	50	50	72	45	60	59	55	53
March	76	73	55	48	57	46	50	58	39	53	39	50	64	50
April	77	68	61	61	58	53	53	30	55	58	43	48	30	34
May	71	64	69	61	59	38	57	42	34	65	44	55	59	33
June	70	75	74	71	38	57	53	50	53	56	55	58	52	38
July	76	76	72	34	70	63	62	66	48	53	52	37	52	47
August	72	71	53	62	65	69	66	69	55	70	55	53	50	52
September	87	61	64	55	71	67	50	69	71	57	48	52	56	66
October	62	79	69	73	59	53	59	60	62	47	41	58	62	40
November	53	37	73	60	57	59	62	71	62	65	60	50	48	37
December	74	72	72	61	67	53	64	66	59	50	50	55	52	59
Means	70	66	66	58	59	56	56	56	54	54	50	54	52	46

The table brings out the difference in persistence between the two places, Honolulu representing a marine tropical climate, and Tokio a continental temperate climate though these two climates are not represented to their fullest degree. For purposes of comparison the period of record used was the same for both places; namely, 1890 to 1924, inclusive. It was thought that if different lengths of record were taken the results might be seriously altered.

As will be observed from the table, a month has the same sign as the preceding month in 70 per cent of the cases. For Hawaiian rainfall (Cox's 10-station average) the corresponding average is 66 per cent; for Honolulu pressure, 65; and for Honolulu wind velocity with a record of only 20 years, 57 per cent.

Using Clough's fifth criterion in the article previously referred to it can be shown that in Hawaii long periods in which a meteorological element, especially temperature, is persistently above or below the normal are much higher than in a random series of events. Beginning with the month of June, 1908, there were 21 consecutive months in which the Honolulu temperature was below normal. There were two cases in which the temperature was above or below the normal for 13 consecutive months, and one case each of 11, 12, and 15 consecutive months. In the record of Honolulu pressure there was one case each of 12, 13, and 20 consecutive months in which pressure was above or below the normal. Such remarkable cases of persistence have not been of such frequent occurrence in Hawaiian rainfall, but beginning with the month of January, 1919, there were 14 consecutive months in which the precipitation was below normal, using Cox's 10-station average.

Evidently, at certain times there is some influence, or group of influences, working, which in itself or themselves tend to persist over a period of several months.

Because of the importance of rainfall in the Hawaiian Islands from a practical standpoint I have made a more exact analysis of the data by finding the coefficient of correlation between each month of the year and the following month. The result is shown in Table 3.

TABLE 3.—*Correlation between Hawaiian rainfall of each month and the following month*

Month beginning	Correlation coefficient r	Probable error ϵ	r/ϵ
January	+0.142	±0.096	1.48
February	+0.126	±0.096	1.31
March	+0.142	±0.096	1.48
April	+0.225	±0.093	2.42
May	+0.394	±0.082	4.80
June	+0.471	±0.076	6.20
July	+0.375	±0.084	4.46
August	+0.394	±0.082	4.80
September	+0.002	±0.099	0.02
October	−0.127	±0.096	1.32
November	+0.321	±0.088	3.65
December	+0.133	±0.096	1.41

It will be observed that the coefficients are much higher during the summer than during other seasons of the year, and the relation thus brought out has some forecast value when applied to summer rainfall for the Hawaiian Islands as a whole. The difference between persistence in the summer and other seasons of the year is present in other meteorological data, and seems to be out of proportion to seasonal differences in variability.

Figure 1 shows the unsmoothed annual values of four meteorological elements, vis, Honolulu temperature, pressure, wind velocity, and Cox's 10-station average of Hawaiian rainfall. Some interesting relations are brought out in this chart. The most important of these is the synchronism between the wind velocity at Honolulu and Hawaiian rainfall, which is not at all surprising in

view of the fact that most of the rainfall in Hawaii is brought about by the forced ascent of the trade winds over the land masses. Another fact, the reason for which is not so evident, is the seesaw relation between pressure and wind movement, and pressure and rainfall. It may be, and probably is, explained by the general principle that high pressure is associated with quiet, clear weather, and low pressure with cloudy, windy weather. Annual temperatures apparently take a course nearly independent of the other elements.

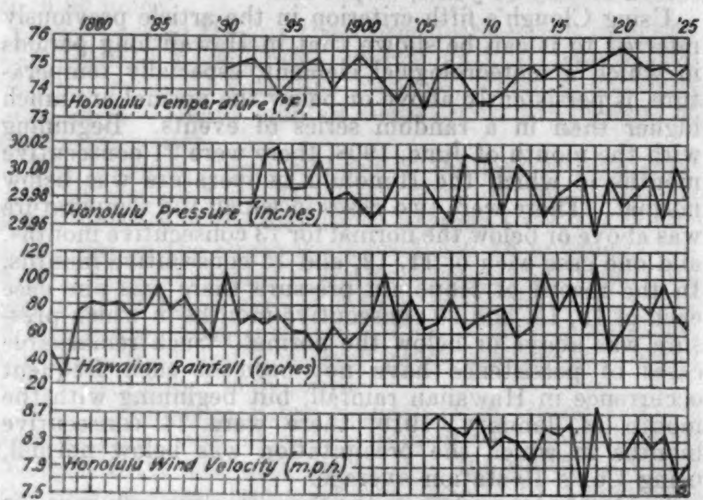

FIG. 1.—Unsmoothed annual values of temperature, pressure, wind velocity, and rainfall (Cox's 10-station average)

CONCLUSIONS

It has been the purpose of this study to show that variations of the weather in the Hawaiian Islands show a systematic tendency, and comparisons were made with the weather elsewhere to show that this tendency was greater than at places in higher latitudes. This, however, could be inferred from what is already known on the subject. Other facts which are new so far as the writer is aware are as follows:

(1) In the Hawaiian Islands, temperatures show a remarkable tendency to persist.

(2) As regards other meteorological elements such as rainfall, atmospheric pressure, and wind velocity, the persistence is less but still clearly apparent in Hawaii.

A knowledge of the fact that wet and dry weather tend to persist considerably in the summer time might be of some value in long-range forecasting. From May to August wet (wetter than normal) months are followed by wet months, and dry (drier than normal) months are followed by dry months in 73 per cent of the cases for the Hawaiian Islands as a whole. For individual sections this would be somewhat less, depending on the locality.

Periodicities probably have little to do with long periods of abnormal weather, and the cause must be sought for elsewhere. The fact that a persistent tendency is shown in the records of weather in the Hawaiian Islands is sufficient to lend encouragement to those who wish to make further studies on longe-range weather forecasting.

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FORECASTING PRECIPITATION FROM LOCAL DATA[1]

C. L. RAY

[Weather Bureau Office, Lansing, Mich., June 10, 1926]

The writer has made a statistical arrangement of the probability of rain following different pressure heights, wind directions, pressure changes, and the several combinations of these factors. The results as presented in the accompanying charts and tables do not show a sufficiently high average of probability to serve their intended purpose as an aid in forecasting. The data are presented, however, in order to show what can be done by this method, and to illustrate the relative importance of the several elements, as they relate to forecasting at this station. Owing to the unsatisfactory results from the forecasting angle, averaging not more than 59 per cent, the discussion will be limited to a brief resumé of the more prominent characteristics revealed by the analysis. There was available a total of approximately 5,450 observations, taken daily at 7 a. m., central standard time, throughout the year, and covering a period of 15 years, 1910 to 1925, inclusive. From these data was calculated the percentage of times precipitation occurred within 24 hours, eliminating from consideration the 12 hours immediately following the observation. This gives the results a comparative value in relation to the results from the synoptic charts. Only the annual probabilities have been given in some instances as it was found that the differences were very slight between the values for the several seasons.

TABLE 1.—*Probability of rain with different pressures and different pressure changes, based on 7 a. m. pressure and 12-hour change and rainfall in 24 hours, from 7 p. m., 5,449 observations*

	Spring	Summer	Autumn	Winter	Annual
Pressure (inches):					
29.74, less	69	52	76	82	73
29.75–84	60	44	59	73	59
29.85–94	62	49	58	78	61
29.95–04	60	48	55	70	58
30.05–14	54	49	53	71	56
30.15–24	46	36	45	71	50
30.25 over	42	34	40	61	48
Total	55	46	52	70	56
12-hour pressure change:					
−0.25 inch or more	78	------	76	77	77
−0.24 inch to −0.15	71	55	65	81	72
−0.14 inch to −0.05	62	56	56	73	63
−0.04 inch to +0.05	60	51	56	72	58
+0.06 inch to +0.15	45	42	45	64	47
+0.16 inch to +0.25	42	34	37	67	46
+0.26 inch and over	51	------	41	62	53
Total	56	46	52	70	56

[1] cf. Chapman, E. H., Quart. Jour. Roy. Metl. Soc. *42*: 289. Ibid. *40*: 347, the relation between atmospheric pressure and rainfall at Kew and Valencia Observatories. In this paper it is pointed out that the relationship between pressure values and rainfall at a single station is small and vague; that the relation between changes in barometric height is also small, but when dealing with mean, pressure values, and rainfall totals a significant relationship is found.—Ed.

In Table 1 are given the average probabilities of rainfall expressed in percentages, following the several 7 a. m. observed sea-level pressure readings. In general the higher the pressure the lower the probability of rain. During the summer months when precipitation is least, the percentage of times when rain may be expected is better than 50 only when the pressure is under 29.75 inches. During the winter period the probability averages above 70 per cent for all observations, with a minimum of 61 per cent for lowest pressure and a maximum of 82 per cent where readings are above 30.25 inches. The winter probabilities are in excess of what would be expected, based upon the normal rainfall for the season, and are evidently due to the greater daily frequency of precipitation, often amounting to only a trace (too small to measure). Taking the data as a whole it is found that there is a slightly better than 50 per cent chance of rainfall where the pressure is 30.14 inches or less, except during the summer period of normally light precipitation. On this basis, if we were to make a blanket forecast, so to speak, in which *rain* is predicted for all cases where the pressure falls below 30.14 and *fair* for all cases where it is above 30.14 inches, the resulting verifying average would be about 55 per cent.

The lower part of Table 1 gives the probabilities based upon the 12-hour pressure change. The annual probability of rain following a fall in pressure of 0.25 or more is somewhat higher than that following pressure readings under 29.75 inches. In other words a considerable fall in pressure in 12 hours is a slightly more favorable indication of rain than is a very low pressure reading considered separately. Where the pressure change is minus, even though a small one, the chance of precipitation following within 24 hours is better than 1 to 1 in all seasons. The "blanket" forecast referred to above, however, fails to show a verifying average of more than 56 per cent. A 12-hour rise in pressure of 0.26 inch or more, during the spring months is followed by rainfall more than 51 per cent of the time. This percentage, while almost on the border line, marks a sharp increase in probability over the groups representing a rise between 0.06 and 0.25 inch. The rapid movement of high and low areas at this season gives to the plus pressure change where it is a sharp one, a forecast value for approaching unsettled weather. Taken as a whole it may be said that either falling pressure or a rapid ries is favorable for rain while rising pressure is less so. These conclusions, while not by any means new in themselves, are given mathematical verification by the results in the table.

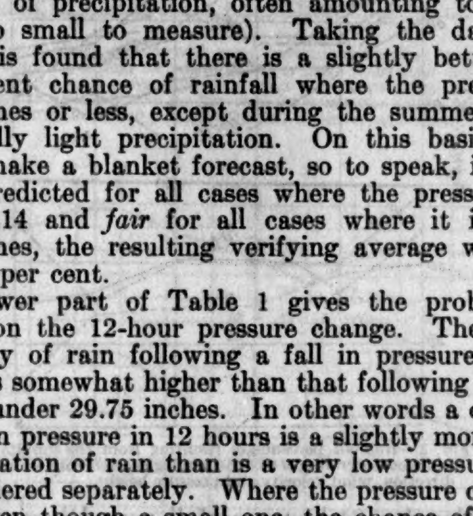

FIG. 1.—Rain probability as a function of pressure and pressure change—data of 5,466 observations

In Figure 1 the simultaneous consideration of pressure and pressure change as related to the 24-hour rainfall is shown. The greatest probability occurs when there is a 12-hour pressure change of −0.25 and a sea-level reading of 29.84 inches or less. Two secondary maximum probabilities occur, one with a minus change of 0.25 with the pressure over 30.15 inches, the other where there is a plus change of 0.25 inch and an observed reading under 29.75 inches. The least probability is found with pressure 30.25 inches or more with a plus change of 0.25 inch or more. Computing the verifying average by making a forecast of rain for all cases where the probabliity is over 50 per cent and of *fair* in all other cases, a resulting average of 59 per cent is obtained, or several points better than where forecasts are made in which the two elements are considered separately. In this connection we find similar investigations of the probability of rain as a function of two elements as made by Blair[2] who in turn refers to studies made by Besson on the same subject. Blair found that the verifying average following this method and using the data for Dubuque, Iowa, was 62 per cent. Quoting his remarks in this connection: "This is only slightly better than the 59 per cent in Table 5 (each element considered separately) and corresponds to the experience of Besson, who says that contrary to expectations the two element combinations do not offer much superiority over the results with one element. However, he constructs eight such figures, giving eight combinations of two elements each, and according as the arithmetical mean of the eight probabilities shown is above 0.50, forecasts rain or no rain, and obtains a verification of 73 per cent for 943 cases."

In Table 2 is given the relationship of the different wind directions to the rainfall within the following 24 hours, using as in the other instances cited thus far, the 7 a. m. observation and eliminating from consideration any precipitation occurring during the 12 hours immediately following the observation. Southeast winds give the most favorable indication of unsettled conditions to follow. Rain occurred in 71 per cent of all cases after an observation of this wind. East and south winds also show better than 60 per cent. The least favorable direction from the standpoint of precipitation is north, which averages only 39 per cent. A forecast of rain or fair according as the average exceeds 50 per cent results in a verifying percentage of 59. North and northwest are the only directions showing less than 50 per cent precipitation probabilities.

TABLE 2.—*Probability of rain within 24 hours, with wind from different directions (R 24 equals number of occurrences of rain within 24 hours; P 24 expresses the same in percentage)*

Direction	R 24	Total	P 24
North	208	528	39
Northeast	248	520	48
East	279	447	62
Southeast	400	567	71
South	474	725	65
Southwest	712	1,260	56
West	331	595	56
Northwest	356	744	48
Total	3,008	5,386	56
Verification			59

[2] Local forecast studies—Winter precipitation, by T. A. Blair, Mo. Wea. Rev. Feb. 1924–52: 79–85.

In Figure 2 and Table 3 the rainfall probabilities are shown as a function of wind direction and pressure height. In this arrangement the maximum probability is found with a southeast wind and pressure under 29.74 inches, giving an average of 92 per cent over the 15-year period. Southeast winds with pressure 29.84 inches or less are a better indication of rain than south winds with pressure under 29.74 inches. They are almost as favorable a sign with pressure 29.94 inches or less as south winds with 29.74 inches or less pressure. As between forecasting rain for southeast winds or for pressure under 29.74, the average probability favors the pressure element, which gives a percentage of 73 as compared with 71 for southeast winds. Least favorable conditions for rain as shown by these figures are northerly winds with the pressure over 30.05 inches. Wind-velocity averages would seem to show a greater probability for rain with increase. Least favorable are velocities under five miles, although not in every instance. The greatest probability occurs with pressure under 29.74 inches and velocity between 5 and 9 miles. The results are not consistent, taken as a whole, however. They also fail to agree with the conclusions drawn by Blair from results obtained at Dubuque, where it was found that the greatest probability occurred with the lightest wind movement. Comparison with Blair's figures, however, does not give a true relationship, as he has considered a 24-hour rainfall period beginning with the time of the observation of the several elements or 12 hours earlier than the rain period considered in the present paper. This would seem to explain, too, the results obtained from his investigation, as it moves the time of the observed rainfall nearer to the time of the wind observation, with the accompanying more or less calm conditions of the storm's central area. Figure 2 gives a graphical story of the results described.

TABLE 3.—*Rainfall percentages resulting from the simultaneous consideration of two meteorological elements, based on 5,386 observations at Lansing, Mich. Precipitation of trace or more within 24 hours*

Other element	Pressure						
	29.74 or less	29.75–29.84	29.85–29.94	29.95–30.04	30.05–30.14	30.15–30.24	30.25 or over
Wind direction:							
North	75	56	49	35	29	42	36
Northeast	71	64	50	49	43	40	42
East	82	73	74	71	59	58	54
Southeast	92	79	75	67	67	70	60
South	76	71	66	66	69	55	54
Southwest	70	52	62	58	58	48	47
West	67	63	48	54	63	57	40
Northwest	61	44	53	49	48	36	45
Wind velocity, miles per hour:							
0–4	60	56	61	51	52	47	29
5–9	78	60	62	60	61	54	53
10–over	67	52	61	64	61	51	68

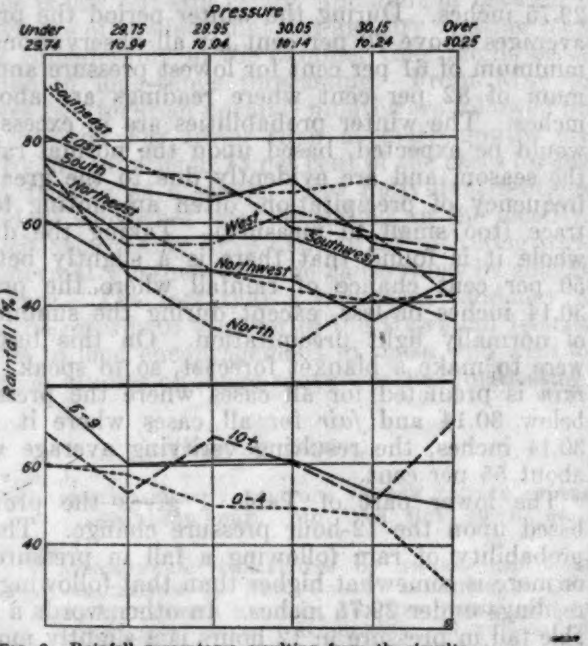

FIG. 2.—Rainfall percentages resulting from the simultaneous consideration of two meteorological elements—wind direction, wind velocity and pressure height

WIND AS MOTIVE POWER FOR ELECTRICAL GENERATORS

By HARRY G. CARTER

[U. S. Weather Bureau, Lincoln, Nebr.]

The main reason why wind-driven electrical generators have not come into general use for rural homes is, probably, the hesitancy of the prospective purchaser to depend upon the capricious wind. He knows in a vague way that there are periods of low wind movement and his lack of information on the subject causes him to doubt the success of a generator so operated.

In order to meet the constantly growing demand for an economical and efficient plant of this type, scientists at the College of Agriculture, University of Nebraska, have been experimenting for several years. They have found that a wind velocity of nearly 10 miles per hour is necessary to charge batteries, the wind wheel being exposed at an elevation of 60 feet. This minimum velocity agrees quite closely with the results of experiments carried on at other places.

In view of this requirement, it is interesting to know how much of the time a 10-mile wind may be expected. What per cent of the time will the wind be too light? How often do these periods of low wind movement occur? What is their average and extreme duration? During what part of the year and of the day are they most frequent? These are vital questions, and while the data may not enable us to foretell the behavior of the wind on a definite day, a knowledge of its behavior in times past gives at least its future average values.

The writer has made a study of the Weather Bureau records of wind velocity at Lincoln for the 10 years 1912 to 1921, inclusive. The most important facts are presented in the accompanying tables and charts. By means of such data the experimenter will better understand the requirements for meeting the actual, rather than the theoretical conditions; and the prospective purchaser may intelligently judge for himself the practicability of a wind-power generating plant.

All measurements were made by a Robinson cup anemometer, the instrument adopted by the U. S. Weather Bureau for measuring wind velocity. The anemometer was exposed above the Brace Physical Laboratory Building on the city campus of the University of Nebraska at Lincoln at a height of 84 feet above the ground.

For the year as a whole a velocity of 10 or more miles per hour for at least five hours of the day occurred on 75 per cent of the days, while a velocity of 10 or more miles per hour for five or more consecutive hours each day occurred on approximately 67 per cent of the days. (See fig. 1.)

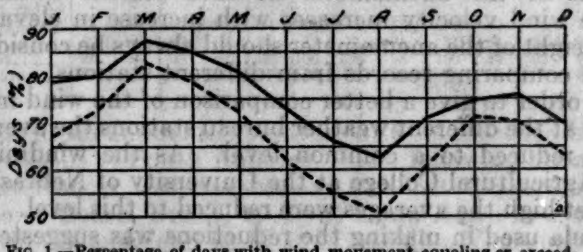

FIG. 1.—Percentage of days with wind movement equaling or exceeding 10 miles per hour for a *total* of five or more hours each day (unbroken line), and percentage with wind movement equaling or exceeding 10 miles per hour for five or more *consecutive* hours each day (broken line), for the 10 years, 1912 to 1921, inclusive, at Lincoln, Nebr.

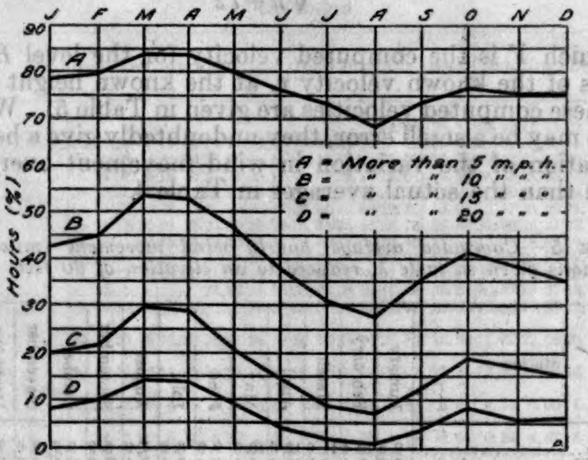

FIG. 2.—Percentage of hours with wind velocity exceeding 5, 10, 15, and 20 miles per hour for the different months, for the 10 years, 1912 to 1921, inclusive, at Lincoln, Nebr.

TABLE 1.—*Percentage of hours with wind movement of stated amounts for the 10 years 1912 to 1921, inclusive, at Lincoln, Nebr.*

Month	Less than 6 miles per hour	6 to 10 miles per hour	11 to 15 miles per hour	16 to 20 miles per hour	21 to 25 miles per hour	More than 25 miles per hour
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
January	22.1	35.2	22.7	11.8	5.2	3.0
February	20.4	34.7	23.0	11.9	5.3	4.7
March	15.7	30.5	24.2	15.2	8.6	5.8
April	16.0	30.8	23.9	15.3	8.6	5.4
May	20.5	32.9	25.2	12.9	5.2	3.3
June	22.6	39.6	23.1	10.6	3.1	1.0
July	26.2	43.1	21.9	6.7	1.8	.3
August	31.3	40.9	20.4	6.1	1.0	.3
September	25.6	38.9	23.0	9.1	3.0	.4
October	23.1	35.4	22.8	10.9	5.6	2.2
November	24.4	37.0	21.4	11.1	3.5	2.6
December	24.5	40.2	19.8	9.2	4.2	2.1
Yearly average	22.7	36.6	22.6	10.9	4.6	2.6

A wind movement exceeding 5 miles was recorded during 77 per cent of the hours; exceeding 10 miles, during 41 per cent; exceeding 15 miles, 18 per cent, and exceeding 20 miles, 7 per cent. The monthly values are shown in Table 1. The same data are presented graphically in Figure 2, which probably emphasizes the change from month to month better than the numerical values in the table.

The diurnal changes in velocity for the four seasons are shown in Figure 3. The increase during the morning and early afternoon and the decrease during the late afternoon and evening are quite pronounced.

It is not necessary to charge batteries continuously; so the wind need not blow at the rate of 10 miles per hour throughout the day. Under average conditions five hours charging every two or three days would seem sufficient to keep the batteries in good condition. From the work carried on at the University of Nebraska it was found that a 16-cell 32-volt 180 ampere-hour battery would furnish current for the needs of the average home for three to five days without recharging, depending upon the amount of current consumed.

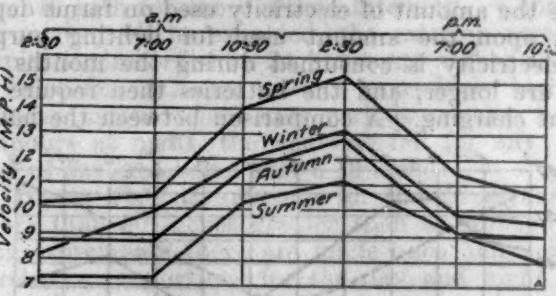

FIG. 3.—Average wind velocity for certain hours of the day for the different seasons for the 10 years, 1912 to 1921, inclusive, at Lincoln, Nebr.

Periods of from three to five consecutive days without sufficient wind to charge the batteries were not of frequent occurrence but occurred often enough to require careful consideration. (See Table 2 and 3.) They seemed to be more frequent in late summer and early winter and least frequent in spring, with a secondary minimum frequency in autumn. Periods of low wind movement exceeding five consecutive days were uncommon, averaging less than one each year, and were quite evenly distributed throughout autumn, winter, and summer, but did not occur during the spring.

TABLE 2.—*Total number of periods of two or more consecutive days in which wind movement did not equal 10 miles per hour for a total of at least five hours each day, for the 10 years 1912 to 1921, inclusive, at Lincoln, Nebr.*

Number of consecutive days	January	February	March	April	May	June	July	August	September	October	November	December	Total for 10 years
2	4	8	4	6	6	5	9	13	13	11	8	7	94
3	3	2	0	2	1	2	7	5	2	3	4	9	40
4	0	0	1	0	3	2	3	1	1	0	2	2	15
5	0	0	0	0	0	2	1	1	0	0	0	0	4
6	2	0	0	0	0	1	1	1	0	1	1	1	8
7	1	0	0	0	0	0	0	0	1	0	0	0	2
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	1	0	0	0	1
10	0	0	0	0	0	0	0	1	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	1	0	0	0	0	1

TABLE 3.—*Total number of periods of two or more consecutive days in which wind movement did not equal 10 miles per hour for five or more consecutive hours each day, for the 10 years 1912 to 1921, inclusive, at Lincoln, Nebr.*

Number of consecutive days	January	February	March	April	May	June	July	August	September	October	November	December	Total for 10 years
2	11	11	3	8	9	5	8	13	17	12	6	17	120
3	5	2	1	4	4	4	10	9	5	3	3	7	57
4	1	1	1	0	2	1	6	6	2	2	3	4	29
5	0	1	0	0	0	4	2	3	0	0	1	1	12
6	0	0	0	0	1	2	0	0	1	1	2	1	8
7	0	0	0	0	0	0	2	1	1	0	0	0	4
8	1	0	0	0	0	1	1	0	0	0	0	0	3
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	1	0	0	0	1
13	0	0	0	0	0	0	0	1	0	0	0	0	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
16	1	0	0	0	0	0	0	0	0	0	0	0	1

Since the amount of electricity used on farms depends mainly upon the amount used for lighting purposes, more electricity is consumed during the months when nights are longer, and the batteries then require more frequent charging. A comparison between the hours of darkness and the wind movement is given in Figure 4. Darkness is considered as beginning one-half hour after sunset and ending one-half hour before sunrise.

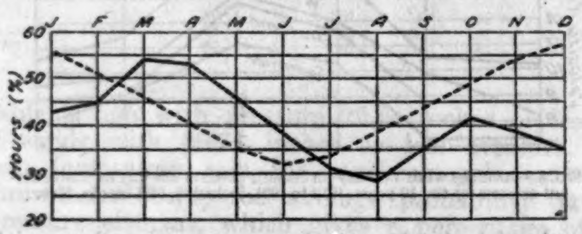

FIG. 4.—Percentage of hours with wind velocity equaling or exceeding 10 miles per hour (unbroken line), and percentage of hours of darkness (broken line), at Lincoln, Nebr., for the 10 years, 1912 to 1921, inclusive

TABLE 4.—*Recorded average hourly wind movement (miles) at certain Weather Bureau stations, with height of anemometer*

Station and height of anemometer	January	February	March	April	May	June	July	August	September	October	November	December	Year
Lincoln (84 feet)	10.7	11.3	12.6	13.0	11.2	10.1	8.9	6.6	9.7	10.5	10.4	10.2	10.6
North Platte (51 feet)	7.6	8.1	9.5	10.4	9.1	8.1	7.2	6.8	7.5	7.8	7.8	7.4	8.1
Omaha (122 feet)	9.1	9.7	10.1	10.1	8.9	7.8	6.9	6.7	7.5	8.2	8.6	8.7	8.5
Sioux City, Iowa (164 feet)	12.3	12.7	13.6	14.6	13.2	11.8	10.1	9.9	11.4	12.2	11.9	11.6	12.1
Valentine (54 feet)	9.8	9.8	11.3	12.4	11.6	10.7	9.7	9.1	10.0	10.2	9.7	9.5	10.3

The average wind velocity at the regular Weather Bureau stations in Nebraska and also at the neighboring station at Sioux City, Iowa, is shown in Table 4. The height of the anemometer at each station is shown. Since wind velocity increases with increase in elevation, the height of the anemometer should always be considered when comparing records from different stations.

In order to give a better comparison of the wind movement at the different weather bureau stations the averages were reduced to a common level. As the windmill at the Agricultural College at the University of Nebraska is 60 feet high the averages were reduced to this level. The formula used in making the reductions was suggested by Stevenson in the Journal of the Scottish Meteorological Society in 1880:

$$V=v\sqrt{\frac{H+72}{h+72}}$$

in which V is the computed velocity for the level H, in terms of the known velocity v, at the known height h.

These computed velocities are given in Table 5. While there may be a small error, they undoubtedly give a better indication of the variation in wind movement over the State than the actual averages in Table 4.

TABLE 5.—*Computed average hourly wind movement (miles) at stations given in table 4, reduced to an elevation of 60 feet*

Station	January	February	March	April	May	June	July	August	September	October	November	December	Year
Lincoln	9.8	10.4	11.6	12.0	10.3	9.3	8.2	7.9	8.9	9.7	9.6	9.4	9.8
North Platte	7.9	8.4	9.9	10.8	9.5	8.4	7.5	7.1	7.8	8.1	7.7	7.7	8.4
Omaha	7.6	8.1	8.4	8.4	7.4	6.5	5.7	5.6	6.2	6.8	7.1	7.2	7.1
Sioux City, Iowa	9.2	9.5	10.2	11.0	9.9	8.8	7.6	7.5	8.6	9.2	8.9	8.7	9.1
Valentine	10.0	10.0	11.5	12.6	11.8	10.9	9.9	9.3	10.2	10.4	9.9	9.7	10.5

In conclusion it may be said that while the data presented may not prove the feasibility of operating electrical generators by wind power, they at least show the possibilities. It would seem that here is a fruitful field for further investigations. The day may not be far distant when hundreds of rural homes will have wind power plants for generating electricity.

CLIMATOLOGICAL DATA FOR ANDAGOYA, REPUBLIC OF COLOMBIA, SOUTH AMERICA

By P. C. DAY

[Weather Bureau, Washington, D. C., Aug., 1926]

Through the courtesy of Mr. E. H. Westlake, vice president, Pacific Metals Corporation, 61 Broadway, New York, N. Y., the Weather Bureau has received regularly for a number of years, copies of the monthly meteorological records made at the mining camp of that corporation at Andagoya, located on the San Juan River in the northwestern part of Colombia, South America. The geographic coordinates of the place of observation are, latitude 5° 4′ north, longitude 76° 55′ west, in the Choco district, at the junction of the San Juan and Condoto Rivers, and about 250 feet above sea level.

On the west the distance in a direct line to the Pacific is about 35 miles, while to the east lie the Western Cordillera of the Andes at a distance of about 50 miles. These mountains are from 4,000 to 5,000 feet above sea level. Between the San Juan River and the Pacific coast lies a range of hills not over 300 feet above sea level.

The instrumental equipment consists of maximum and minimum thermometers, raingage, and hygrometer, all of standard make and properly exposed. The thermometers are read daily and the precipitation is measured twice daily, 7 a. m. and 7 p. m., local sun time.

Observations of rainfall began in August, 1914, and of temperature in September, 1917. A short record of relative humidity was made during portions of 1917 and 1919.

In addition to the above a record of precipitation covering about three years was furnished by the same company from a branch camp at Buena Vista, about 25 miles north of the main camp at Andagoya.

TABLE 1.—*Means and extremes of temperature (°F.), 1917–1925, Andagoya, Colombia*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean maximum	89.6	89.3	89.6	89.8	89.2	89.2	89.3	89.2	89.5	89.6	88.2	88.0	89.2
Mean minimum	74.5	74.5	74.5	75.0	74.5	74.1	73.6	73.6	73.5	73.8	73.7	74.0	74.1
Mean	82.0	81.9	82.0	82.4	81.8	81.6	81.4	81.4	81.5	81.7	81.0	81.0	81.6
Highest	96	95	98	97	96	100	100	98	100	99	95	96	100
Lowest	68	71	70	70	72	70	70	70	70	69	68	66	66

The mean annual temperature 81.6° is exceeded in very few regions of South America. The following means are of interest in this connection: 82.4° at Quixeramobim, State of Ceara, Brazil; 82.6° at Dada-Nawa in southern British Guiana; and 83.5° at Maracaibo, Venezuela. In the warmest months, January to April, the mean temperature at Andagoya averages 82.1°.

TABLE 2.—*Monthly and annual precipitation (in inches), Andagoya, Colombia*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1914	......	......	......	......	......	......	......	14.45	26.11	23.43	11.75	22.15	......
1915	19.93	23.65	17.30	16.77	18.16	19.62	32.91	24.18	29.96	29.90	25.67	17.23	275.28
1916	26.81	16.76	26.29	26.50	21.81	34.14	31.31	33.23	20.71	29.43	23.57	20.33	310.89
1917	19.89	26.25	19.30	39.15	30.16	18.61	29.10	27.01	29.12	24.49	28.65	25.32	317.05
1918	20.33	25.95	24.34	23.59	24.55	30.46	25.06	28.14	16.85	17.09	31.30	26.20	294.16
1919	14.51	13.60	8.55	19.86	20.77	28.96	26.16	22.51	16.01	15.37	30.30	21.11	237.71
1920	25.39	13.35	24.28	20.40	29.94	24.44	25.85	26.76	26.82	21.96	25.21	23.76	288.16
1921	36.29	25.86	19.54	30.43	21.42	29.79	17.30	33.40	27.74	17.90	18.87	19.50	298.04
1922	32.85	28.22	26.65	22.58	36.06	20.59	12.56	25.93	26.36	23.95	23.92	19.40	298.97
1923	27.41	13.78	13.66	31.92	20.35	23.95	18.88	37.33	47.83	21.08	20.61	20.79	297.59
1924	25.23	......	......	28.88	24.36	20.33	23.51	17.96	20.61	20.37	19.27	13.11	......
1925	16.44	14.39	8.69	......	19.25	25.57	17.12	18.67	22.53	15.06	17.97	17.13	......
Mean	24.10	20.18	18.86	26.01	24.28	25.13	23.61	25.80	25.88	21.67	23.09	20.50	279.11
Mean, 7 p. m. to 7 a. m.[1]	20.58	16.52	14.43	20.25	17.86	19.56	18.60	19.92	21.27	17.33	17.09	16.18	219.59
Mean, 7 a. m. to 7 p. m.[1]	3.52	3.66	4.43	5.76	6.42	5.57	5.01	5.88	4.61	4.34	6.00	4.32	59.52
Maximum in 24 hours	7.34	5.90	8.11	6.22	5.41	6.80	3.36	5.14	6.04	6.24	4.67	4.35	8.11
Maximum in 12 hours	6.87	3.95	8.04	5.90	5.39	6.02	3.33	5.12	6.00	4.05	3.92	3.82	8.04
Mean number of days with precipitation	26	21	23	25	26	24	26	27	27	24	27	27	303

[1] Hours of measurement changed to 6 p. m. and 6 a. m. in March, 1925.

The temperature is unusually uniform throughout the year; during the eight-year period, the maximum observed, 100° F., was recorded on only four days, the minimum of 66° on but one date, and the minimum was below 70° on only five days.

The individual monthly amounts for the period of record at Andagoya show the rainfall to be rather uniformly distributed over the several seasons, as well as over the different years of the period, a feature not usual in regions with such heavy annual amounts. Individual monthly totals ranged from 8.55 to 47.83 inches, but they were generally between 20 to 30 inches.

The feature of outstanding importance in the distribution of precipitation is the great frequency and intensity of night rains. The average annual number of nights with rain is 277, while the average for the day falls to 158. Nearly 80 per cent of the precipitation occurs between 7 p. m. and 7 a. m., as shown in the table given, and for this period the mean intensity for nights with rain is about 0.80 inch as compared with less than 0.40 inch for the daytime intensity. Contrary to what might well be expected, the extreme amounts of precipitation recorded in 24 hours are rather moderate, and those for 12 hours are not excessively high. The maximum amounts for these periods are due to heavy downpours at night, the heaviest fall for any 12-hour period of daylight being only 3.10 inches.

At Buena Vista the average for the three-year period is more than 50 inches greater than at Andagoya, but the measurements there are made once daily only and the relative proportions for the day and night periods are not shown.

The mean annual precipitation of 279 inches at Andagoya and an even greater amount, 331 inches, at the sub-station, Buena Vista, together with a 7-year average precipitation of about 280 inches as recorded from 1910 to 1916 at Buenaventura, located south of Andagoya at the mouth of the San Juan River, show remarkable contrasts to those occurring in the region east of the Cordillera Occidental, the western range of the Andes. The decrease in annual rainfall from the coast to the elevated interior amounts to more than 250 inches, as shown in the following table. The marked differences in the annual amounts are likewise maintained in the monthly amounts for the different seasons.

TABLE 3.—*Mean monthly and annual precipitation (inches), at six stations in Colombia*

Stations	Length of record in years	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Andagoya[1]	12	24.10	20.18	18.86	26.01	24.28	25.13	23.61	25.80	25.88	21.67	23.09	20.50	279.11
Buena Vista[2]	3	20.51	14.58	17.85	31.60	30.77	27.29	28.23	25.98	30.86	26.78	35.41	30.87	330.73
Buenaventura[3]	7	17.90	12.33	11.34	25.60	28.40	23.76	22.35	26.66	27.93	34.66	28.08	21.64	280.65
Medellin[4]	15	2.70	3.27	3.36	6.53	7.80	5.44	4.13	4.68	6.16	7.02	5.07	2.53	58.78
La Manuelita[5]	11	3.19	3.10	4.16	6.09	5.37	2.92	1.50	1.49	2.98	5.81	4.78	3.20	44.59
Bogota[6]	20	2.37	2.42	3.77	5.44	4.28	2.11	1.78	1.96	2.20	5.57	5.06	3.00	30.96

[1] 5° 4′ N., 76° 55′ W., elevation 250 feet. Period, 1914–1925.
[2] 5° 30′ N., 76° 51′ W., elevation not given. Period, 1923–1925.
[3] 3° 49′ N., 77° 11′ W., near sea level. Period, 1910–1916.
[4] 6° 10′ N., 75° 45′ W., elevation 4,950 feet. Periods, 1875–1878 and 1908–1918.
[5] 3° 36′ N., 76° 27′ W., elevation 3,500 feet. Period, 1900–1910.
[6] 4° 36′ N., 74° 5′ W., elevation 8,700 feet. Period, 1894–1922.

Sources of data:
BUENAVENTURA AND BOGOTA: SARASOLA, S., Noticia del nuevo observatorio (San Bartolomé de Bogotá) con algunos datos sobre la climatologia y magnetismo de Colombia. Bogota, 1924.
MEDELLIN: Climatological Data, West Indies and Caribbean Service, U. S. Weather Bureau. July, 1925.
LA MANUELITA: CHAPMAN, FRANK M., The Distribution of Bird Life in Colombia. *Bulletin of the American Museum of Natural History*, vol. 36, 1917.

The annual precipitation over the coast districts and lower valleys of northwestern Colombia, nearly 300 inches, as shown in the above table, is apparently the highest that occurs in either North or South America, being considerably in excess of the amount received at Mooretown, Jamaica, 222 inches, or at Greytown, Nicaragua, 256 inches.

In commenting on the heavy precipitation in that region, the assistant manager of the company, Mr. N. C. Marshall, states:

Certain months are supposed to be dry, but they will not be so regularly every year. The day rainfall is fairly constant, at an average of from 4 to 6 inches per month. The only thing that can be said about the night rainfall is that more rain falls from

June to November than during the other months of the year. This includes the time when the big floods come down the San Juan and Condoto Rivers, which may be expected during the months of September to November, and much less frequently during the other months. What dry season there is will come from December to May, although it can not by any means be called dry.

In regard to the rainfall during the day, the greatest part of it falls from 7 to 9 o'clock in the morning and from 5 to 7 in the evening. If it were otherwise, it would be very hard to get any outside work done at all, but there are really more sunshiny days than the record of rainfall would lead one to suppose.

It is rather uncommon for rain to continue falling all day long and if these days were kept track of, I think that it would be found that the most of them occur during the months of heaviest rainfall from June to November. For this reason this time of the year has been called the wet season, and from December to May the dry season, but the rain gage does not bear this out; as, for instance, the second highest monthly rainfall on record, 39.15 inches, occurred in April.

The native way of naming the seasons is very simple and quite flexible; when a few consecutive days are rainy they say it is winter, and when four or five days have been bright and sunshiny they call it summer, no matter what time of the year it may happen to be.

Commenting on the large amount of precipitation during the night hours, Mr. Westlake states:

With regard to the preponderance of precipitation during the night this is a feature of the climate which I have heard commented upon by the half-dozen or more engineers whom we have sent to Colombia since 1912. In fact this feature of the climate of the Choco region was noted and commented upon as far back as 1854 in an article by John C. Trautwine (author of the well-known engineering handbook and one of the builders of the Panama Railroad) in a paper entitled "Rough Notes of an Exploration for an Inter-Oceanic Canal Route by Way of the Rivers Atrato and San Juan, in New Granada, South America, see journal of the Franklin Institute, March to October, 1854."

The only records of relative humidity are those at noon covering parts of the years 1917 to 1919. No data appear for August or September of any of those years. Interpolation of values for these months gives the unusually high value of 82 per cent at noon for the annual mean. The extremes of the monthly means are 86 per cent in February and 78 per cent in October.

C. E. P. BROOKS ON VARIATIONS OF PRESSURE FROM MONTH TO MONTH IN THE REGION OF THE BRITISH ISLES [1]

By A. J. HENRY

In this study the author has used the data of monthl deviations from normal pressure for the stations published in *Réseau Mondial* to trace the shifting in latitude and longitude from month to month of the centers of greatest deviation in the region of the British Isles. Only the pressure deviations were dealt with, since those of temperature and precipitation can be explained in terms of the pressure.

The monthly charts afforded little insight into the pressure distributions which were responsible for them; hence it became necessary to examine the daily weather charts for the months considered.

In the beginning the progressive movement of these centers was studied by constructing a series of overlapping 30-day charts March 1 to 30, March 2 to 31, and so on. These charts very clearly showed the gradual movement in a northeasterly direction of the areas of excess or deficit. The construction of 30-day overlapping charts being too laborious, at the suggestion of Dr. George C. Simpson, a shorter method was adopted.

In this method the area covered was that between 30° and 70° north latitude and 70° west to 80° east longitude and only deviations of at least ±5 mb. were considered. When deviations of that amount occurred in two successive months a barbed line was drawn connecting the position of the center during the first month with its position in the second month.

If these centers in successive months were as a rule quite independent of each other, there would be no reason why these arrows should be directed toward one point of the compass rather than another. If, on the other hand, the centers in successive months really indicate two successive positions of the same center, and if there is a tendency for centers to move in one direction rather than in another, the majority of the arrows should point in this direction. The investigation was carried out on three separate series of charts, which between them cover a period of 41 years:

(*a*) A series of monthly charts of pressure deviations over the northern hemisphere covering the years 1873 to 1900.

(*b*) Working charts of deviations of pressure over the globe for the period January, 1910, to April, 1919, prepared in connection with the *Réseau Mondial*.

(*c*) A series of rough working charts of the deviations of pressure over North America, the North Atlantic, western and central Europe, covering the period June, 1922, to October, 1925, prepared in connection with various investigations into current weather.

The *Réseau Mondial* charts were the first set to be dealt with, and it was quickly evident that the movements of the centers in the southern half of the area were very largely from west to east, while in the northern half there were a considerable number of instances in which the movements were apparently from east to west. The work was accordingly repeated, the pairs of months being separated into two classes, the first class including those in which the position of the center during the first month was north of 55° N., while the second class included those in which the position of the center during the first month was south of 55° N. The results of the investigation are shown in Table I (not reproduced). * * *

From Table I we see that between 70° and 55° N. 60 centers of excess gave an apparent movement to the eastward compared with 35 to the westward, and 60 centers of deficit showed a movement to the eastward compared with 49 to the westward. Between 55° and 30° N. 41 centers of excess showed a movement to the eastward compared with 15 to the westward, and 23 centers of deficit showed a movement to the eastward compared with 16 to the westward. In all four groups the easterly movement predominated, although to a much greater extent with centers of excess than with centers of deficit.

The predominance of apparent easterly movement holds in all four seasons, though it is greatest in summer. We find that for each 10 centers of pressure deviation giving apparent westward movement in any one season the number of centers giving an apparent movement to the eastward is: Winter 12, spring 17, summer 21, autumn 16. Many of the instances of apparent movement to the westward are due to the happening that a center of deviation which was shown in the chart for one month had by the following month either moved eastward out of the area or had decreased to an intensity of less than 5 mb., while at the same time a new center of deviation had appeared in the west of the chart. It appears in fact that the month is too big a unit; if the charts had been drawn for each 10 or 15 days, the predominance of apparent easterly movement would have been much greater.

Tracks of centers of excess and deficit were constructed and published. These followed more or less regular courses, somewhat analogous to the paths of cyclones that apparently circle the north pole. The centers of excess show a tendency to move from Alaska southeastward to the center of the United States, thence eastward to a position between Bermuda and Nova Scotia, continuing in that direction to the Azores, thence usually northeastward to the British Isles or across them to Scandinavia, and finally again eastward into northern Russia or the Kara Sea, the whole journey taking about six months, though no single center was found that persisted long enough to move from Alaska to Russia.

[1] Quarterly Journa l of the Royal M eteorological Soc. 52: 263-276.

The average life of a center was found to be only about 3 months and a certain number appeared suddenly one month and could not be traced the next.

The movement as above indicated conforms rather closely with that of anticyclones that cross the north American Continent.

The paths of centers of deficit were found to be less regular than those of excess, North America being almost free from centers of deficit amounting to the limit set in the study. This agrees with the experience of the present writer, who is of opinion, that the explanation is to be found in the dispersion of cyclones which obtains in North America. Mr. Brooks notes that a number of centers originate in the neighborhood of Newfoundland and move in an easterly direction. This also is in conformity with experience on this side of the Atlantic; I may offer the suggestion, however, that the explanation of the origin in the location named, may be found in the very marked increase in energy of many cyclones that pass from the continent to the ocean over the Canadian Maritime Provinces. The pronounced contrast in air and water temperatures encountered in this region may be a factor in producing the sudden increase in energy and the associated low levels of pressure in cyclones that traverse that region.

Finally the author discusses the use of the paths of excess and deficit in their relation to forecasting the probable deviation from the normal of the monthly pressure one month in advance. He says:

The study of the tracks of centers of excess and centers of deficit suggests a possible method of forecasting the deviation of pressure from normal for one month from a consideration of the distribution during the preceding month by methods similar to those employed in daily forecasting. Since the life history of a monthly "center" does not occupy anything like so many months as there are days in the life history of an ordinary anticyclone or depression, and the monthly tracks, especially of centers of deficit, are even less regular than the day to day tracks of depressions, the process evidently requires a gread deal of care.

In order to estimate the chances of success in a forecast based only on the movements of centers of excess or deficit, Table 3 has been prepared, showing for each season for a number of areas the numbers of centers which (a) originated suddenly in the area or (b) moved into the area from some other region.

A center which moves into any region from outside, so long as it follows the normal track, would give a generally successful forecast; a center which appears in that region with no previous sign of its existence would give a failure. Hence as a preliminary test of the possibilities of forecasts deduced from the tracks, unaided by any other consideration, we may take (b) as successes and (a) as failures. This gives us the following frequency of successes and failures in Europe (Table 4):

TABLE 4.—*Probable result of monthly forecasts for Europe*

	Successes	Failures
December to February	6	5
March to May	15	1
June to August	5	4
September to November	5	2

From this table we should expect a reasonable amount of success in spring but doubtful results during other seasons. Evidently some improvement in the methods is required before long-range forecasting from the movements of centers of pressure deviation can promise success. Forecasts based on the movements of centers of excess in general offer greater chances of success than those based on the movements of centers of deficit.

PART 2 OF GREGG'S AEROLOGICAL SURVEY OF THE UNITED STATES

RESULTS OF OBSERVATIONS BY MEANS OF PILOT BALLOONS

By BURTON M. VARNEY

Like Part 1 of the Survey, Part 2 has been issued as a SUPPLEMENT to the MONTHLY WEATHER REVIEW, No. 26,[1] Part 1 having been SUPPLEMENT No. 20, dealing with "Results of Observations by Means of Kites."

The present SUPPLEMENT deals necessarily with free-air conditions over the country east of the Rockies only, sufficient data not having as yet been accumulated from the remainder. The main purpose of the paper being to supply data in a form that will be useful to aviation in such matters as the planning of flight schedules, Mr. Gregg presents extensive tables showing frequencies of different wind directions and speeds at flying levels, in addition to the abundant data now available for altitudes above those at which flying is commonly done. The information is classified under nine regional sections, an excellent arrangement which lends itself to the study of that portion of the country in which one may be interested. The free use of graphs and charts makes it possible for those less concerned with statistical details to form a satisfactory picture of the average free-air conditions over the United States.

Very briefly summarizing the salient points of the work, we have the following:

Average wind velocities in the free air.—At the surface these are highest as a rule in spring, while those of autumn are closely like the average annual velocities. For the country as a whole wind velocities approximately double from the surface to 500 m., which is about the level at which the gradient wind is reached. The increase is often much greater, especially at night and in winter, and it is least in the daytime and in summer. In the next thousand meters, little change of velocity, great irregularity, and often a decrease of velocity is the rule. Thence to the base of the stratosphere there is a gradual increase, except at southern stations in summer, where frequently there is almost no wind at any height within the range of observations.

Diurnal variation in wind velocities.—The author rightly takes pains to emphasize the fact of the reversal of phase which takes place between the ground and a short distance above it. The surface layer of air, characterized by the well-known afternoon maximum and early morning minimum of wind velocity, is exceedingly thin, only 50 to 100 meters, and above that the diurnal change of velocity is exactly reversed. At the surface the diurnal range is but 1 to 2 m. p. s.; at the level of the gradient wind it averages 2 to 4 m. p. s., but above that critical level it decreases to practical extinction at 1,500 to 2,000 meters.

Frequency of free-air winds of different velocities.—Experience has shown that it is the winds of 10 m. p. s. or more which must be reckoned with in planning workable flight schedules. It is therefore of interest to note that—

At the surface the frequency of winds of 10 m. p. s. or more is very small, averaging from 5 to 10 per cent, with a maximum as a rule in spring and winter. There is no very marked variation in different parts of the country.

A decided increase occurs immediately above the surface * * * At "ordinary flying levels"—i. e., 500 to 1,000 meters—winds

[1] This SUPPLEMENT is on sale by the Superintendent of Documents at 20 cents per copy.

of 10 m. p. s. or more occur from 20 to 25 per cent of the time in the Southern States and 40 to 45 in the Northern * * *. There is a fairly large seasonal range, from about 20 in summer to 45 in winter, the seasonal values as well as the annual being highest in the Northern States. Velocities of 20 m. p. s. or more occur in general at these levels less than 5 per cent of the time.

At greater heights the seasonal and latitudinal variations increase very decidedly, as well as the frequency of the higher velocities themselves. For example, at 4 and 6 kilometers, winds of 10 m. p. s. or more occur in the Northern States 45 per cent of the time in summer, 85 in winter * * *; in the Southern States except Florida the values are 35, 70 * * *, respectively.

Relation of velocities in the free air to directions at the surface.—After presenting the facts with regard to changes of wind direction with altitude (these are summarized later) it is pointed out that—

The different directions at the surface are associated with characteristic changes in velocity with altitude quite as definitely as with changes in direction * * *.

From the surface to about 500 meters there is a large increase with all directions; it is greatest with south to southwest winds and least with north-northeast to east winds.

At higher levels lowest velocities are still found above easterly surface winds, particularly east-northeast and east; highest velocities, however, occur above west to northwest winds at 2 kilometers and higher instead of above south to southwest * * *.

The seasonal and latitudinal variation, small at the surface, increases decidedly with altitude, the highest velocities and the nearest approach to a westerly direction occurring when and where the poleward temperature gradient, and therefore pressure gradient also, is strongest.

Frequency of free-air winds from different directions.—For the year as a whole there is in general at the surface comparatively little variation, although westerly winds are somewhat more frequent than are easterly, except during summer in Florida and southern Texas. There is also in all sections a seasonal swing from a slight preponderance of south component winds in summer to a similar preponderance of north component winds in winter, with the single exception of the Plains States, in which southerly winds are more frequent than northerly throughout the year. For the most part calms are observed only about 1 to 2 per cent of the time * * *.

There is in most parts of the country a pronounced swing above the surface to westerly directions as those of greatest frequency. This tendency is strongest in winter and increases with altitude in all seasons. For example, in the Northern States west component winds prevail at 4 kilometers 90 to 95 per cent of the time in winter, about 80 in summer, and 85 to 90 for the year as a whole. In the Southern States a west component is still strongly predominant in winter, but much less pronounced in summer. In the extreme south—i. e., Florida and southern Texas—an east component is more frequent than a west at all levels in summer. Generally speaking, a south component in the winds at upper levels occurs more frequently than a north component in the Southern States, whereas the opposite condition is found in the Northern States.

The turning of the winds aloft.—As a result of the thousands of observations which have been collected, it is now possible to set forth the extent to which free-air winds at various levels turn clockwise or counterclockwise from the direction of the wind at the earth's surface in detail commensurate with the importance of the subject to the aviator. Wind direction at the surface is intimately connected with both direction and velocity aloft. The degree of consistency of these relationships is considerable. From the extensive tables presented one may easily take out the facts relative to turning of the winds up to 6 kilometers for each of 16 surface directions and for calms by seasons and for the year. Similarity in these relations over large areas fortunately makes it possible to treat them under groups for Northern States and Southern States instead of the nine groups used in the rest of the work. It is impracticable here to quote the many summarizing statements made by the author, concise as they are, with regard to the frequencies and the amounts of the two classes of turning aloft. We may, however, quote the summary of summaries:

Taking a broad, general survey of the data presented * * * we find that those surface directions from which there is the largest deviation with altitude are in general also those which have the largest percentage frequency of turning, either to the right or to the left. Thus, considering annual values, southerly winds show at 4 kilometers a large deviation to the right and a very high frequency of clockwise turning; northerly winds, a large, though less decided, deviation to the left and a fairly high frequency of counterclockwise turning. Near the surface there is a similar consistency. In other words, to quote Doctor Meisinger, "The greatest average deviation occurs with the greatest reliability of turning; the least deviation occurs with the least reliability of turning."

Free-air resultant winds.—This final section of the paper is in some respects the most interesting of all. Here resultant velocities and directions for the country east of the Rockies are given on clear little maps, one series of which, particularly important because it deals with the usual flying levels, shows the facts for the surface, 500 m. and 1,000 m. for the four seasons and for the year. From these maps can be clearly recognized the west component in the winds at all seasons at all three levels in the Northern States, and for the same region a marked increase in resultant speed aloft as the westerly component becomes stronger, the winter season showing this most strikingly. In the highest level (1,000 m.) the variations of resultant speed with season and with latitude are most pronounced.

Of perhaps greater interest from the theoretical point of view is the series of maps portraying the summer, winter, and annual isobars and resultant wind directions and speeds at 500, 1,000, 2,000 and 4,000 m. above sea level. Among the more striking features of this series are the following:

In summer over the region between the Mississippi and the Rockies, the persistence of south-component winds up to at least 2,000 meters and the decided change to westerly and northwesterly up to 4,000 meters over the northern part of that region.

In summer over the eastern United States (except Florida), the rapid weakening of the south component with increasing altitude and latitude as the resultant wind swings north of west, this being already accomplished by the time 2,000 m. is reached.

In winter over the entire region (except Florida), the drift from westerly directions at all levels, with north component increasingly predominant the higher the latitude and altitude.

Florida stands in a class by itself, with its resultant southeasterly winds at all levels in summer, a tendency which in winter, however, persists through the lower levels only; between 500 and 1,000 m. in that season a shift to southwesterly has already taken place.

The supplement closes with a brief discussion of the relations between the facts set forth in this section and the seasonal shift of the terrestrial pressure system, with special reference to the migration of the horse-latitude belt of high pressure and its southward displacement aloft relative to its position at the surface. The results confirm theoretical conclusions reached by Shaw and others.

SOLARIMETERS AND SOLARIGRAPHS

SIMPLE INSTRUMENTS FOR DIRECT READINGS OF SOLAR RADIATION INTENSITY FROM SUN AND SKY

LADISLAUS GORCZYŃSKI, D. Sc.

[Washington, October 28, 1926]

SYNOPSIS

The paucity of solar radiation data is chiefly due to the lack of simple and portable instruments for direct readings. To fill this lack, there is described, under the name of "Solarimeter," a combination of a thermopile (modified Moll type), closed hermetically, under a hemispherical glass cover, and directly combined with an electrical measuring apparatus of a simple millivoltmeter type. A system of two contact screws makes it easy to employ the solarimeter either for sun and sky observations on a horizontal surface or for pyrheliometric readings at normal incidence. For the latter a small pyrheliometric tube on a special holder is connected with the solarimeter box. All these new constructions should be considered as secondary instruments, which necessitate comparisons with normal pyrheliometers.

Directions for using and testing the solarimeter are given, in which is emphasized the employment of a solar screen for determining the sky radiation by Doctor Kimball's method.

A recording solarimeter (solarigraph) is also briefly discussed and the importance of sun and sky radiation measurements emphasized not only for meteorological stations, but also for agriculturists, botanists, for aviation (transparency of the atmosphere), and finally for photographic and medical purposes, by using violet and ultra-violet filters.

GENERAL REMARKS

Meteorologists are in full accord that in the series of meteorological elements solar radiation takes the predominant place. Nevertheless, we note the strange fact that of the many thousand meteorological stations in the world a totally negligible number are making solar radiation measurements. In the large and well developed network in the United States only about six stations are making pyrheliometric readings or records regularly, and in other countries or continents the proportion is still lower.

The reason for this very unsatisfactory state of things is not an underestimation of the importance of solar radiation for the study of the atmosphere and its changes, but rather the lack of simple instruments for direct readings of this predominant meteorological element. It is obvious that for daily observations at ordinary meteorological stations and for general use for those interested (agriculturists, botanists, medical men, etc.) only very simple, portable, and robust instruments can be employed. One needs an apparatus that will directly indicate the momentary values of radiation intensity like a thermometer or other direct reading instrument. This objective is nearly gained by using thermopiles for solar radiation work.

The first thermoelectric pyrheliograph was used by Crova, professor at the University of Montpellier (France), some 40 years ago. Similar apparatus using thermopiles, recording or direct reading, but based on the thermoelectrical method, were constructed by Féry, Moll, Kalitine, Dorno, and recently by Linke, Henry, and others. Those usually employed at meteorological stations and research observatories are the Weather Bureau thermoelectric recording pyrheliometer devised in 1923 by Kimball and Hobbs at Washington, and the thermoelectric pyrheliograph constructed in Europe and described in the MONTHLY WEATHER REVIEW (June, 1924) by the writer. But recorders intended for automatic notation of solar radiation values must necessarily possess a recording galvanometer with a clock mechanism, and in addition—for pyrheliographs recording radiation at normal incidence—a special equatorial mounting with another clock permitting it to follow the sun. Although by no means too difficult for regular use, all these recorders are relatively expensive and require daily service, which prohibits their use at simple meteorological stations.

The solarimeter is particularly adapted for stations of not only the higher order, but also for the simplest observing points.

On account of the extraordinary simplicity of reading the solarimeter, the new instrument makes possible the realization of the wish of meteorologists of all countries to include solar radiation measurements in daily routine observations, made at the same time as regular readings of air temperature, pressure, wind, etc.

Solarimeters are, moreover, especially useful in all sunny lands, such as the tropical and equatorial regions. Indeed, the best example of the great need of simple solar radiation apparatus is the fact that the greater part of the meteorological stations in India are at present equipped with the so-called "radiation thermometers," consisting of a black bulb in vacuo. Only the existing extreme lack of simple apparatus for direct readings of solar radiation can explain why the "radiation thermometers" are still used, notwithstanding their well-known and very serious meteorological defects.

Another important feature of the solarimeter is its adaptability for use with light filters. By employing a special solution, as, for example, copper sulphate in distilled water, the intensity of the violet and ultra-violet part of the spectrum can easily be obtained. Such an adaptation is especially valuable for medical climatology, actinotherapy, and also for photography, as it may be used for determining the proper time exposure. In addition to the copper-sulphate filters for shorter wave lengths, other light filters may be used. For the infra-red portion of the spectrum, marble glass is very efficient. Further information concerning the question of light filters may be found in the paper "Light-filter measurements made by the Polish Solar Radiation Expedition to Siam in 1923, and at Tougourt in the Sahara Desert in 1924," published in the Quarterly Journal of the Royal Meteorological Society (pp. 210–218, vol. 51, April, 1926, London).

Finally, it is possible to apply solarimeters for aviation by connecting them with sensitive galvanometers; in this case one can rapidly obtain an idea of the transparency and thickness of clouds and fogs.

We give below the description of new direct-reading instruments, which are very simple even for the most inexperienced observers and several times less expensive [1] than the pyrheliographs. To these direct-reading instruments, designed for both solar and sky radiation, we propose to give the name of "Solarimeters" in order to distinguish them from pyrheliometers, which serve generally for radiation intensity of the sun at normal incidence.

[1] While thermoelectric recorders cost in round figures from $300 to $500, the solarimeters can be obtained for about $65 in Paris, where they are regularly manufactured by Richard, using the solarimetric thermopiles made by Kipp at Delft, Holland. The European construction would certainly be improved by combining the solarimetric thermopiles with American-made millivoltmeters, in view of the excellence of the latter instruments manufactured in the United States.

THE SOLARIMETER: SOME DETAILS OF ITS CONSTRUCTION

The great simplicity of the solarimeter is evident by inspecting Figures 1 and 2. This portable little instrument for measuring solar radiation consists of an hermetically closed (in dry air) brass cylinder containing a solarimetric thermopile under a hemispherical cover of special flint glass and directly connected with a convenient needle galvanometer of simple millivoltmeter type. The characteristic feature of the solarimeter is that its thermoelectric elements generating the current under the influence of solar radiation are directly attached to the galvanometric system (magnet with moving coil and needle), so that these two essential portions forming the complete apparatus are placed in the same solarimeter box. The cylinder, with the thermopile, being fitted on the inner cover of the box, all connections are made inside.

The thermopiles especially made for solarimetric use consist of very thin plates of manganin and constantan of low resistance (about 8 ohms), with active junctions placed on a straight line in the center. In comparison with the original Moll type, it must be noted that the thermoelements forming the rectangular solarimetric pile are straightened and uniformly covered with a special lacquer layer without intervals between separate thermoelements. This special construction and new arrangement of thermoelements with an unbroken and plane surface is essential for solarimetric work in order to avoid the changing influence of the oblique sun's rays resulting from their different incidence angles between horizon and zenith.

Though the solarimeter is designed primarily for direct readings of both sun and sky radiation, by merely changing the contact screws it is possible to connect the galvanometer, contained in the solarimeter box, with a pyrheliometer tube mounted in a special holder. With the tube normally directed to the sun, we thus obtain immediately a direct-reading pyrheliometer

The details of this construction are shown on the diagram, Figure 1.

The pyrheliometric tubes used in connection with the solarimeter box are placed on a special holder (fig. 2.); the operation of directing them normally to the solar rays is very easily carried out by viewing a spot of light from the sun on the sight placed in the tube.

The thermopile used in the pyrheliometric tube is the same as that for solarimetric use, but without a hemispherical glass cover. In the opposite end of the pyrheliometric tube is a sphero-cylindrical lens, which magnifies the galvanometer deflections about four times.

The use of this lens is not obligatory, and an ordinary plane protecting glass would be sufficient to obtain good deflections. But the use of a sphero-cylindrical lens is not only very useful with low radiation values (and especially when employing light filters), but has other important advantages. The spherical and cylindrical radii are so calculated that the sun's rays are focused in the form of a narrow line covering just the active junctions of the thermopile, and by means of a rectangular diaphragm placed in the middleof the pyrheliometric tube the greater part of the thermopile remains in shadow.

Readings of the solarimeter are scarcely more complicated than the observation of an ordinary radiation thermometer. For making a measurement the box is placed horizontally, the slide in the cover opened, and the first determination of zero on the galvanometer scale made. One need not bring the needle to the true zero of the scale. The slide is then closed, the cover opened to expose the thermopile, and the deflection of the galvanometer needle again read. The thermopile itself acts in less than two seconds, but the final deflection of the needle is reached after a somewhat longer period, due to the lag introduced by the thick glass hemisphere. The cover is then closed, the slide opened, and the second

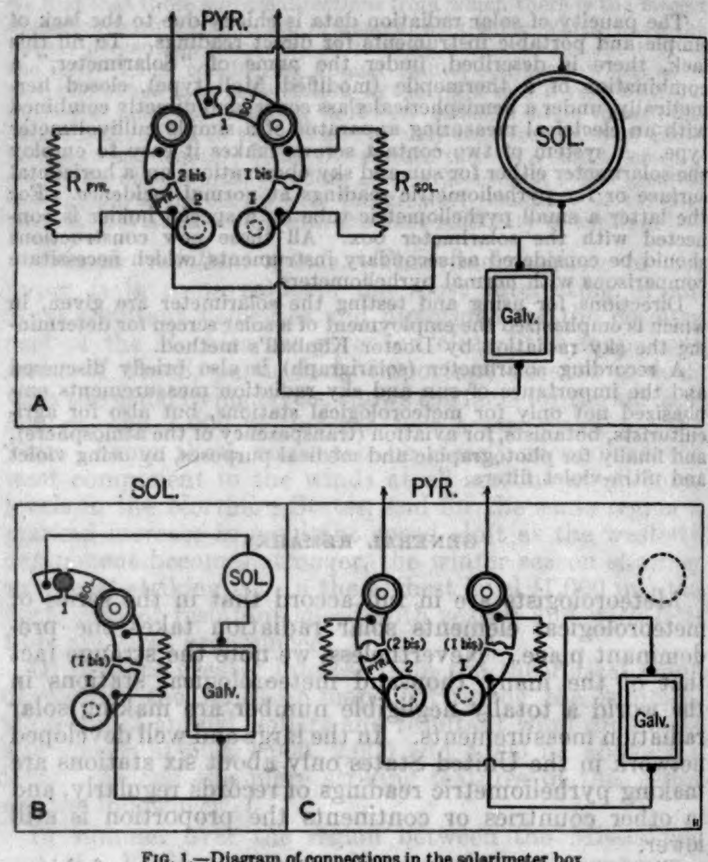

FIG. 1.—Diagram of connections in the solarimeter box

EXPLANATION OF SIGNS

Diagram A

Sol.—Solarimetric thermopile under hemispherical glass cover.
Galv.—Magnet with movable coil and needle.
1, 2, 2_{bis}.—Alternative positions of the larger contact screw.
I, I_{bis}.—Alternative positions of the smaller contact screw.
In the positions 2 and I the contact screws are in their neutral positions, and do not influence the electrical connections of the apparatus.
R_{sol} and R_{pyr}.—Additional resistances which can be eliminated by putting in I_{bis} and 2_{bis}, the respective contact screws.
Two circles with arrows each represent two contacts where the leads for pyrheliometric connections should be attached.

Diagram B.—Connections for solarimetric readings; 1 and I for ordinary use

For ordinary use the larger contact screw is placed at 1, the smaller one at I (its neutral position). With this position of the two contacts, the additional resistance R_{sol} is included. If the smaller contact is removed from 1 to I_{bis}, the additional resistance is eliminated. The increase of the galvanometer deflection is, however, moderate in this case, the resistance R_{sol} being relatively small and chiefly used to give to the coefficient a certain desired value.

Diagram C.—Connections for pyrheliometric readings; 2 and I for ordinary use

Two movable contact screws remain in their neutral positions (smaller screw at I, large one at 2). With this position the additional resistance R_{sol} and R_{pyr} are both included. If the contact screws are removed from 2 to 2_{bis} and from I to I_{bis}, respectively, the two additional resistances are both eliminated. The galvanometer deflection is very largely increased in this case and such a combination may be used for small radiation values or when employing light filters. Other possible combinations (as, for example, 2_{bis} and I) are of secondary interest and will be only occasionally used; for every such combination a special coefficient must be determined in order to be able to convert the respective deflections into absolute value.

determination of zero made as before. In case the zero readings differ, their mean value should be subtracted from the deflection produced by sun and sky. The differences are due in part to a slight heating of the glass hemisphere during the observation (due to the relatively great thickness and volume of the glass); time is necessary, therefore, to permit the needle to return to its true zero.

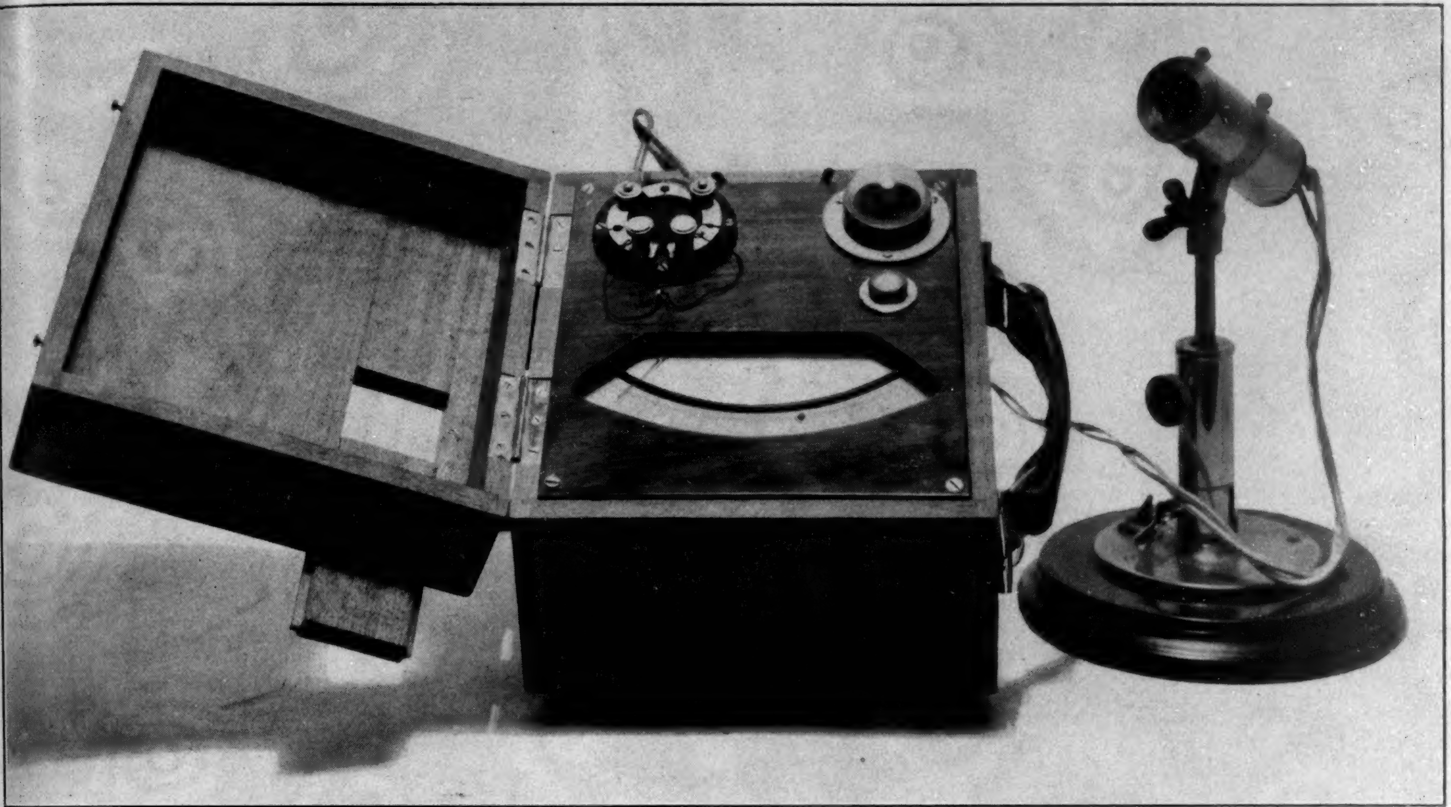

FIG. 2.—Solarimeter box for direct readings of the sun and sky radiation on a horizontal surface (connected also with a pyrheliometric tube on stand for the sun radiation intensity at normal incidence)

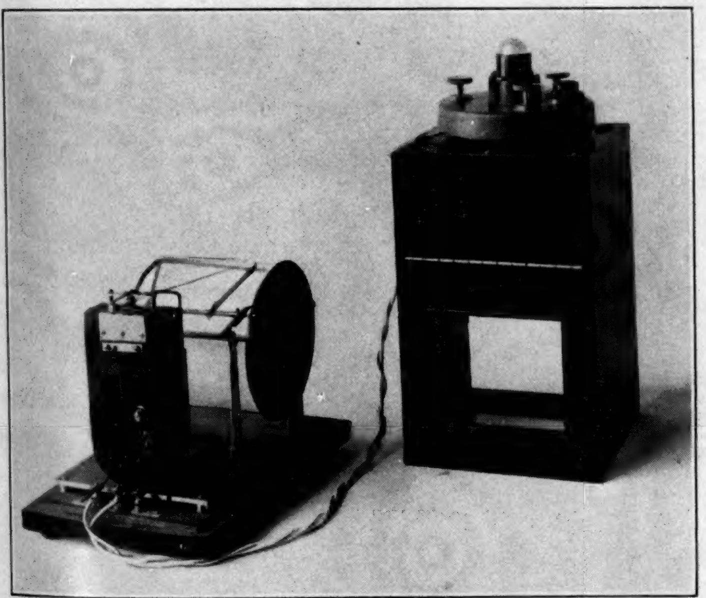

FIG. 3.—Solarigraph: Solarimetric pile under glass cover exposed outdoors to the sun and sky radiation and connected by leads with a recording millivoltmeter installed indoors

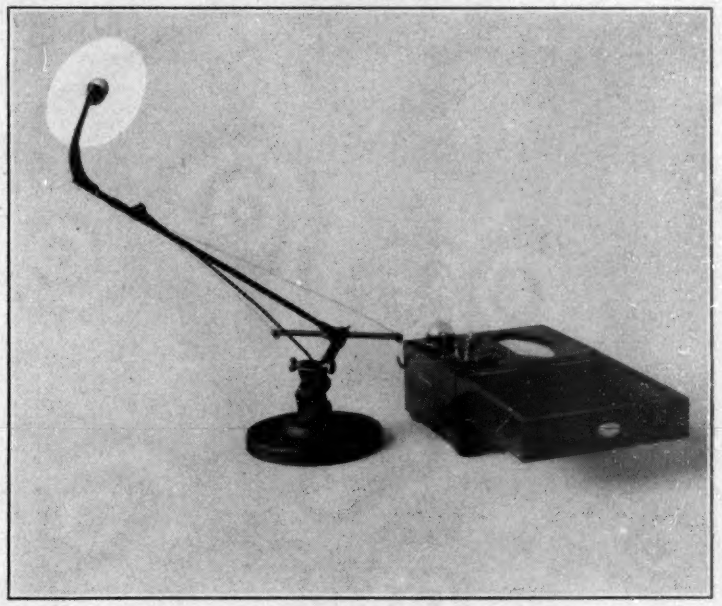

FIG. 4.—Solar screen used in connection with solarimeter for readings of sky radiation

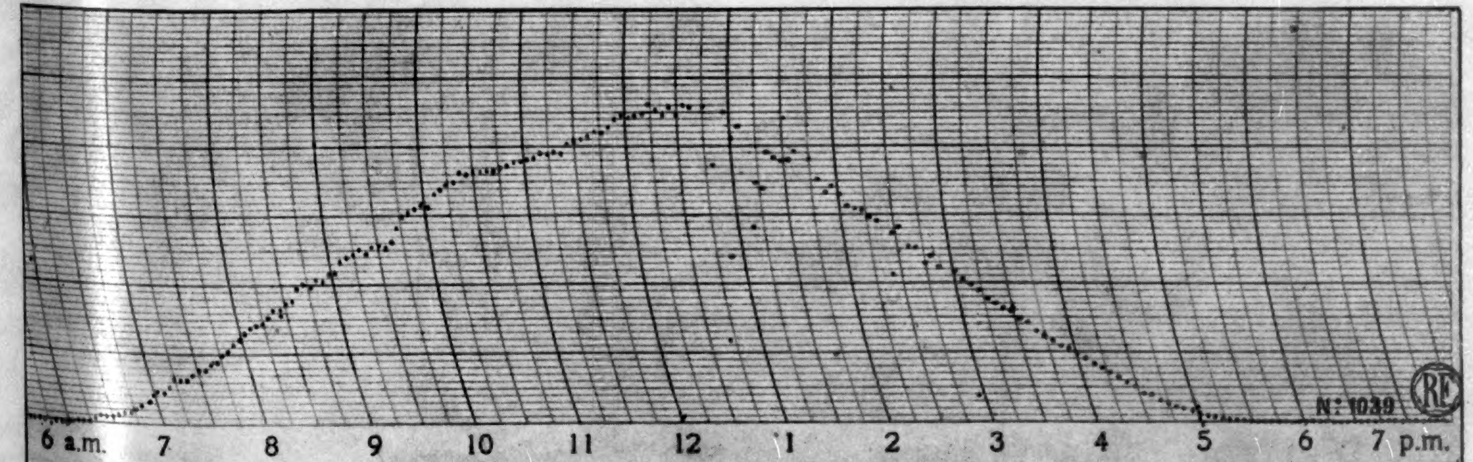

FIG. 5.—Record obtained with a solarigraph on October 4, 1926, at the Solar Radiation Observatory of the U. S. Weather Bureau, American University, District of Columbia

In some galvanometers (millivoltmeters) a slight tapping helps to accelerate the movements of the needle.

The scale of the solarimeter has 100 divisions (0–100) and additional resistances, R_{sol} and R_{pyr} (fig. 1), are so chosen that the coefficients (value of one scale division in absolute units) represent certain determined and round numbers. The coefficients are generally expressed in gram-calories per square centimeter per minute, but a corresponding value for milliwatts per cm^2 or other unit can easily be deduced.

For test purposes the pyrheliometric tube is connected and the contact screws placed at 2 and I (their neutral positions); then two additional resistances R_{pyr} and R_{sol} are included. The deflections of the galvanometer needle when the pyrheliometer tube is used are very nearly proportional to values obtained simultaneously with a normal pyrheliometer. Dividing the value of the latter in gram-calories per minute per $cm.^2$ by the number of divisions on the solarimeter scale, the coefficient for the normal pyrheliometer is directly obtained. If the contact screws are placed at 2_{bis} and I_{bis} or other combinations are used (instead of at 2 and I), the value of the coefficient is smaller and must be determined by comparisons of readings with different resistances.

The value 0.02 (100 scale divisions equal to 2 gram-calories per minute per cm^2) is generally used to convert the deflections (by pyrheliometric connections with the contact screws at 2 and I), in gram-calories per min. per $cm.^2$ If the additional resistance R_{pyr} and R_{sol} are not conveniently chosen by the manufacturer, the observer may easily obtain this coefficient by inserting in series with the ordinary wire connection from the solarimeter box to the pyrheliometer tube several inches of high-resistance manganin wire lead. The proper length of this lead necessary to obtain the correct coefficient is obtained by the cut-and-try method, using a standard pyrheliometer for test purposes.

The testing of the solarimetric pile is somewhat more complicated than that of the pyrheliometric tube. The pile, under its hemispherical glass cover, receives not only direct solar radiation, but also diffuse sky radiation; furthermore, solar radiation acting on the horizontal solarimetric pile is always smaller (proportional to cosines of the zenithal distance of the sun) than simultaneous intensity at normal intensity.

It follows that in order to compare the solarimeter readings, giving the total radiation from the sun and sky on a horizontal surface with simultaneous readings of a pyrheliometer exposed at normal incidence to the sun alone, the following computations must be made:

(*a*) The sky radiation must be separately observed by using a simple solar screen (see solar screen designed by Doctor H. H. Kimball, fig. 4), which is placed between the sun and the solarimeter pile; in this case only the diffuse radiation from the sky gives the solarimetric deflection.

(*b*) The value of the sky radiation is then subtracted from the ordinary solarimetric readings (without solar screen), and thus the value of the sun's radiation only is obtained.

(*c*) The latter value if compared with the simultaneously obtained solar radiation value, using a normal pyrheliometer exposed perpendicularly to the sun's rays, by multiplying it by cosines of the corresponding zenithal distance of the sun, or, which comes to the same thing, by the sine of the sun's altitude. Thus the coefficient for solarimetric readings is directly calculated.

The following example shows clearly the necessary steps:

[AMERICAN UNIVERSITY, WASHINGTGN, D. C., OCTOBER 22, 1926]

(A)

11:26 to 11:35 a. m. (standard time) corresponding to 11:33 to 11:42 a. m., true solar time.

Zero position before reading	0.4
Solarimeter reading of sun and sky	28.0
Zero position after reading	.1
Solarimeter reading (corrected) of sun and sky	27.7

(B)

Solarimeter reading (deflection) with solar screen	2.9
Zero position (two readings, before and after sky deflection, mean value)	.2
Solarimeter reading (corrected) of sky only	2.7

(C)

Average value 11:33 to 11:42 a. m. (true solar time) of the solar radiation intensity obtained with a Marvin pyrheliometer (No. 3) was 1.17 gr. cal. per min. per $cm.^2$ (zenithal distance of the sun at 11:38 a. m. true solar time, is 50°.1).

The coefficient K for solarimeter No. 4855 will therefore be—

$$K=\frac{1.17\times\cos 50°.1}{27.7-2.7}=\frac{0.749}{25.0}=0.03$$

The value 0.03 is obtained with additional resistance R_{sol} (contact screws at 2 and I). When this resistance R_{sol} is eliminated (by putting the small contact-screw in I_{bis} instead of I), the solarimetric coefficient will be smaller. It is generally nearly 0.02 in this case (contact-screws at 2 and I_{bis}).

If a coefficient value greater than 0.03 is desired, it can be obtained by the addition of a convenient length of small manganin lead to the resistance R_{sol}. In this case the additional leads must be attached to the special bobbin R_{sol} placed inside the solarimeter box. Although practically such tests should and will be made in an observatory and the solarimeters delivered to the observers with the corresponding coefficients, it is not amiss to indicate the procedure for testing for observers who would not only be willing but who would have the proper standard normal instruments in their possession to enable them to repeat the standardization.

We may add that the solar screen of Doctor Kimball's design, illustrated in Figure 4, was extensively used in 1914 at Mount Weather, Va., for standardizing a Callendar recording pyrheliometer where a glass cover is used. The valuable results of Doctor Kimball's painstaking investigations (see MONTHLY WEATHER REVIEW, August, 1914), give many hints for testing horizontally exposed pyrheliometers.

RECORDING SOLARIMETER (SOLARIGRAPH)

Though, as pointed out above, the solarimeters are made primarily as a portable instrument for direct short exposure to the sun, and not for permanent outdoor installation, they can also be adapted for recording purposes. (See fig. 3.) In that case the same solarimeter pile is installed on a special holder, which should be permanently fastened at a convenient place outdoors.

The solarimeter pile, always hermetically sealed in dry air, can remain permanently in the open air without danger of condensation forming inside its glass cover, but the outer surface of the glass should be cleaned from time to time. By means of flexible leads this instrument is connected to the recording galvanometer, which should remain inside a building. The needle galvanometer (of a simple millivoltmeter type) mechanically recording, chosen for the solarigraphs, is similar to that used for the

thermoelectric pyrheliographs manufactured by Jules Richard in Paris.

The new Richard recording galvanometers (millivoltmeters) are, however, specially adapted for solarigraphs. By using coils with low resistance, approximately the same as that of the solarimetric piles, a marked increase in deflections was obtained. The sensitivity of the solarigraph is sufficient to get a deflection even with cloudy weather; characteristic variations are obtained on the diagrams, provided the thickness and transparency of the cloud changes.

In Figure 5 is shown a solarigraph record obtained on October 4, 1926, at the Solar Radiation Observatory of the U. S. Weather Bureau, American University, District of Columbia, where, through the courtesy of Professor Marvin, our solarigraph was calibrated. I am particularly indebted to Dr. H. H. Kimball, in charge of the Solar Observatory, and to his assistant, Mr. Irving F. Hand, for their kind help and very valuable suggestions during my stay at the observatory.

The record of October 4, 1926 (fig. 5), was obtained during a mostly clear day, although some clouds (visible between 12:30 and 1:30 p. m.) caused certain irregularities in the curve. Such a solarigram can be used for calculations, for instance, by planimetric methods, of the daily sums of solar and sky radiation on a horizontal surface.

Both direct-reading and recording solarimeters are made with two or more ranges, which permit the obtaining of greater deflections during cloudy or winter days with low sun. A very useful and important feature of the solarimeter is that it is able to give interesting records even on cloudy days, when the normal pyrheliometer gives no indication at all.

NOTES, ABSTRACTS, AND REVIEWS

WILLIS ISLAND METEOROLOGICAL STATION

A meteorological station on an island so small and low and far to windward of large land masses that its climate is almost as purely marine as if the island were a ship is Willis Island in the south Pacific east of Australia. Willis Island lies 250 miles east of the north Queensland coast, approximately in latitude 16° S., longitude 15° W. Above ordinary seas it is less than 500 yards long and about 200 yards wide, and its summit is just under 30 feet above low water. Across it blows the southeast trade at a velocity that rarely is less than 5 m. p. h., and frequently is over 20 m. p. h. for long periods.

It is some six years since the Commonwealth Bureau of Meteorology established a station on the island. This was done largely to keep an eye on tropical cyclones approaching the coast of Australia. In addition to the usual surface observations, a series of pilot-balloon observations has made possible a preliminary analysis of free-air conditions in this trade-wind region. The following excerpts are adapted from a paper dealing with the seasons 1922–23 and 1923–24, by Dr. E. Kidson, entitled: "Observations from the Willis Island Meteorological Station," in volume 17 of the Report of the Australasian Association for the Advancement of Science, 1924 (the Government Printer, Adelaide, 1926).

To most people it is the winds of Willis Island that will be of greatest interest. Except for short breaks in the cyclone season, due either to passing cyclones or to the advent of the northwest monsoon, the southeast trade blows almost continuously, the mean direction being from southeast by east. In the six months November to April about 70 per cent of the winds are from between south and east, and in the winter months between 80 and 90 per cent. As far as the results go, they indicate that the wind velocity is greatest in the months when the pressure is rising, with a maximum in April, and least when the pressure is falling. The diurnal variation of the wind is especially interesting, since it can not be affected to any large extent by the land. * * * There is a maximum frequency of easterly winds in the hours just before sunrise. This is followed by a maximum for the east-southeasterlies in the three hours preceding noon. Thereafter the southerly component becomes more prominent, and south-easterly to southerly winds have their maximum frequency during the 16 hours to 18 hours period. In the northwesterly quadrant the winds tend to become more northerly in the forenoon hours and more westerly in the afternoon. * * *

The lowest velocity is recorded in the early afternoon, at about 14 hours or 15 hours. After sunset there is a fairly rapid increase to a maximum at about 22 hours to 23 hours.

The diurnal variation seems to consist chiefly, therefore, in the production of an easterly component in the morning and a westerly in the afternoon. The mean velocity is 15.7 miles per hour (7.1 meters per second). * * *

Pilot balloon ascents were made once daily during the seasons 1922–23 and 1923–24. Among the first points noted with regard to the ascents are the small change in direction with height and the low height at which a maximum velocity is reached. * * * It must be remembered that for the upper levels results are available for clear days and days of light wind only, and consequently they may not represent mean conditions. It is unlikely, however, that the impressions they give are very misleading. Above 1 km. the direction gradually becomes more variable, southerlies and westerlies being more frequent. Above 4 km. it would seem that southwesterlies prevail, while at still higher levels it is most probable that northwesterlies are the most frequent. At the high levels winds from the northeasterly quadrant are the least frequent.

The winds do not in every case veer in the lower levels from the surface direction. In fact, the ratio of the number that back to the number that veer between 50 m. and 450 m. is 1 to 1.8. This ratio was obtained in both seasons, and is the same for winds of all types. The reason for this constancy is not clear. The northwesterly winds veer to a greater extent than the southeasterly.

Such evidence as there is tends to show that in general the velocities begin to fall off before 1 km. is reached and continue to do so over the range covered by the balloon ascents. Strong winds are rare, the strongest gusts recorded on the surface being about 18 m/s (40 m. p. h.). Velocities greater than this were only rarely met with in the first kilometer above the surface, though 29 m/s (65 m. p. h.) was reached on one occasion. Were a cyclone to approach very near the island these speeds would, of course, be greatly exceeded.—*B. M. V.*

THE CAUSES OF GLACIATIONS

In a review of Prof. A. P. Coleman's "Ice Ages: Recent and Ancient" (Macmillan, 1926), C. E. P. Brooks writes as follows (in *Nature*, London, August 28, 1926), touching the far-from-solved problem of the causes of glaciations:

* * * These phenomena offer a definite meteorological problem, which the author sets out clearly in words which are worth quoting:

"Under normal conditions the world has a relatively mild and equable climate with no permanent ice at low levels even in the polar regions.

"From time to time * * * there have been relatively short periods of cold accompanied by a great extension of mountain glaciers, and sometimes also by the formation of ice sheets at low levels. In the most severe visitation of the kind ice sheets invaded the Tropics on three or perhaps four continents.

"Ice ages are, in most cases, broken by interglacial periods of milder climate. Sometimes this occurs two or three or more times, indicating a comparatively rapid oscillation from cold to warm and warm to cold.

"All parts of the world have their temperature lowered during an ice age, the Tropics as well as the temperate and Arctic zones."

The author then turns to the consideration of causes, but gives only a rather mechanical discussion of the various theories of climatic change which have been put forward from time to time. Wegener's theory of continental drift is mentioned, but without

enthusiasm. Elevation perhaps comes nearest to a solution, but fails to account for world-wide cooling. The conclusion is that no single cause suffices. "Some combination of astronomic, geologic, and atmospheric conditions seems to be necessary to produce such catastrophic events in the world's history."

The difficulty of the problem is increased by the apparently haphazard way in which glaciations have developed. Time and again the author comments on the paradox of field work, especially on Permo-Carboniferous tillites, beneath an almost vertical sun in a temperature suggestive of anything but ice. On the other hand, so far as is known at present, the Antarctic continent escaped glaciation until the close of the Mesozoic, though of course the great Antarctic ice sheet may hide traces of many older glaciers. The northeast of North America, where the Quaternary ice sheets reached lower latitudes than anywhere else, has suffered glaciation over and over again. In the upper Carboniferous this region bore glaciers which indeed pale into insignificance beside the contemporaneous ice sheets of the south, but would be sufficiently remarkable in any other period. The same region was ice-covered in the Devonian, the Ordovician, at the close of the Proterozoic, in the lower Huronian (a photograph shows the remarkable feature of a Huronian tillite smoothed and striated by a Pleistocene ice sheet), and perhaps at two horizons in the Archæan—seven or eight glaciations in the same or neighboring areas. Other regions which have suffered repeated glaciation are Alaska, South Africa, and southeast Australia, though South Africa was not glaciated during the Pleistocene.

It almost seems as if, given certain conditions, and especially a world-wide cooling, glaciers and even ice sheets can develop in any latitude, but have a preference for certain localities. From this point of view it may be only an accident that the two great ice sheets of the present day occur in high latitudes. Their formation is not entirely a matter of temperature, since we are faced by the idea that during most of geological time the polar regions were free of land ice even while lower latitudes were being glaciated. Apart from pole wandering, the only theory which throws any light on this anomaly is Paschinger's, not mentioned by Coleman, that glaciation depends on the relation between the zone of maximum snowfall and the snow line. It may be profitable to try to fit this theory to the facts before us.

As we go from the lowlands up the slopes of a mountain range, we find that the snowfall increases up to a certain level, above which it again decreases; this level depends mainly on the humidity and the temperature during the wettest season. Quite distinct, depending mainly on the summer temperature, is the snow line. If the snow line is above the zone of maximum snowfall, the glaciers will be small; if the snow line is the lower, the glaciers will be large, and with sufficient snowfall may descend to low levels. In the moist equatorial regions the two zones are close together, and a small depression of the snow line would produce a considerable extension of the glaciers.

It seems probable that glaciers or ice sheets must always *originate* on high ground, but for a glacier to develop into an ice sheet a large area of more or less level ground is required at a temperature low enough for the ice to spread out as a piedmont glacier. In high latitudes this land may be low, but in low latitudes it must be initially at a high level. Once the ice sheet has reached a certain size, however, it imports its own climate, and the initially high plateau may be depressed nearly to sea level without necessarily destroying the ice sheet. There are several reasons for this. One of the most important is that a snow surface reflects four-fifths of the solar radiation falling on it, and another is that a large ice sheet is naturally occupied by an anticyclone with outwardly directed winds. The relations between snow line and zone of maximum snowfall probably depend on conditions of storminess and vertical temperature gradient which are due to general causes; when these are favorable, glaciers will form which may develop into ice sheets in suitable localities, determined partly by configuration, which is independent of latitude, and partly by location relative to storm tracks and oceans. The latter proviso causes the repetition of glaciation in certain localities which are not necessarily the coldest parts of the globe. During the course of an ice age the most suitable location may change, which brings us back to Coleman's speculation that the Greenland ice sheet may represent the continuation of the eastward trend of glaciation in America, having commenced later than the American ice sheets and persisting after them.

The author has done good service by uniting in one volume a large mass of material which was formerly only available in scattered papers or, in the case of his own observations, had not previously been published. The volume maintains the high standard which we expect of the publishers; it is lavishly illustrated by photographs of great interest, and the only error which the reviewer has noticed is the name "Grygalski" on page 286.—*C. E. P. Brooks.*

THE CLIMATE OF NORTH-EAST LAND

In a paper in the *Geographical Journal* for September on the weather of North-East Land, Spitsbergen, during one month in the summer of 1924, Mr. K. S. Sandford has collected some evidence of value in relation to the problem of glacial anticyclones. In this relatively small but almost entirely ice-covered area he found no fixed anticyclone but a definite tendency toward the establishment of anticyclonic conditions with radial gravitational winds. This intermittent glacial anticyclone is blotted out by interference from outside the area but quickly reestablishes itself. Winds are markedly outflowing and lead to an augmentation of the bordering ice at the expense of the higher parts of the interior. On the other hand, interference from the outside is great and leads to melting of ice in the bordering zone and to a less extent in the interior. During the maintenance of anticyclonic conditions there is some indication of a pulsation, from calm to blizzard. Mr. Sandford believes that on New Friesland, on the mainland of Spitsbergen, there is a similar but modified system. Other parts of Spitsbergen have an insufficient ice covering for its development. Up to the present there are no winter observations available from North-East Land.—*Repr. from Nature (London), September 6, 1926.*

EXTENT OF ORCHARD HEATING IN SOUTHERN CALIFORNIA

The fruit-frost service of the Weather Bureau, in charge of Mr. Floyd D. Young, is compiling data on this subject, which when completed will form the first authoritative information with regard to it. The work is divided into eight districts, for each of which it is hoped to have complete data before the spring of 1927. In summarizing the work for the Redlands-San Bernardino district, Mr. A. W. Cook, of the Weather Bureau, writes as follows (*California Citrograph*, July, 1926):

> There are 29,691 acres of citrus trees in the entire Redlands-San Bernardino fruit-frost district, of which 5,789 acres, or 19.5 per cent, are equipped with heaters. The increase in acreage protected since the spring of 1925 is 2,977, or 51.4 per cent of the total. On the basis of fifty 9-gallon oil heaters to the acre, 2,483,550 gallons, or roughly 250 carloads, of oil are required for one filling of the heaters. The Redlands section alone requires about 187 carloads of oil for one filling.

A ONE-MAN THEODOLITE

The August, 1926, issue of *Meteorologische Zeitschrift* contains a description, with illustration, of this device, which appears to be new in the field of aerology. The advantages of a one-man instrument for use on meteorological expeditions or other situation where reduction of personnel is essential are obvious.

In the new instrument the horizontal circle is retained in the form hitherto used, but the vertical circle is ingeniously incorporated within the field of vision of the telescope. The operator with his right eye not only follows the balloon with the aid of the cross hairs, but, aided by their lower vertical member as an index, he with the same eye reads the vertical angle upon an engraved glass circle. Set off at interpupillary distance to the left of the main eyepiece is the ocular of a microscope through which the observer looks, via a prism, upon the scale engraved on the horizontal circle.

Both horizontal and vertical circles are divided into whole degrees. Reading to tenths of a degree is accom-

plished by fitting the horizontal circle with a six-minute vernier, and, in the case of the vertical circle, by depending upon the magnification, aided by the lower cross-hair member, for estimating the tenths.

One may infer that a certain agility will be required of the operator in using two eyes at different tasks almost simultaneously. This should be by no means an insuperable obstacle to the usefulness of the new one-man theodolite.

In the instrument described, the diameter of the objective is 36 millimeters, magnification 10 times, and field of view 5.5°.—*B. M. V.*

ESTABLISHMENT OF METEOROLOGICAL STATIONS IN MONGOLIA

(Translated from Petermann's Mitteilungen, 1926, Heft 1/2)

* * * Dr. W. B. Schostakowitsch, director of the Meteorological and Magnetic Observatory at Irkutsk, has been establishing during the last two years a meteorological observing service in Mongolia under commission from the Mongolian Government.

In addition to the meteorological observatory at Urga (in Mongolian: Ulan Bator Choto) (47° 55′ N., 106° 50′ E.) there are at present seven stations:

Uljassutai (47° 44′ N., 96° 52′ E.).

Wangin (49° 28′ N., 98° 51′ E.).

Chatyl (50° 30′ N., 100° 32′ E.) at the south end of the Kossogol.

Dsain Schabi (47° 46′ N., 101° 03′ E.).

Sangin (47° 52′ N., 106° 48′ E.).

Ude (44° 35′ N., 111° 10′ E.).

San Reisse (48° 00′ N., 112° 42′ E.).

All the stations were established with the support of the Central Geophysical Observatory at Leningrad.

The stations at Urga and Ude were already in existence, and for the period 1894–1903 had furnished valuable observations. From Uljassutai there are only the few observations of H. Fritsche for 1879–80. All the other stations are quite new and of the greatest importance for our future enlightenment as to the climate of northern Mongolia, now known only in bare outline. With the exception of Ude and San Reisse, all the stations lie in the Changai Mountains region, and it is very much to be desired that the town of Kobdo, from which we have complete observations only for 1896 and for scattered months in 1895 and 1897, should be included in the net of stations.

At the Urga Observatory, modern registering apparatus such as barographs, thermographs, hygrographs, and heliographs are in use, and a Michelsson actinometer. Beginning with October of this year, study of the upper air currents with pilot balloons was begun.

Through the observations of this new, albeit wide-meshed net, we have now a good basis for following into Mongolia the cold and warm waves in thin surface layers of air, which, originating over the northern ice-covered sea and spreading thence eastward and westward, H. von Ficker has traced as far as the western edge of the Russian Altai Mountains, even to Barnaul. From von Ficker we have the newest and most comprehensive description of the climate of central Asia. (Geogr. Ann., 1923, pp. 351–400.)

In the course of the next year the work of the stations will be extended to include magnetic and seismic observations. * * * —*Paul Fickeler, Munich.*

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, AUGUST, 1926

By J. BUSTOS NAVARRETE, Director

[Observatorio del Salto, Santiago, Chile]

The month of August was relatively dry, the atmospheric régime in the central zone being characterized by stability and continuity. During the first seven days the régime was a high-pressure one, with cloudy weather and cold in the central zone, and some drizzle and scattered rains in the south.

Between the 8th and the 11th an important depression influenced the country, causing general bad weather. On the 11th it rained from Coquimbo to Chiloe, the maximum precipitation being registered at Punta Tumbes, 100 millimeters.

Between the 12th and the 17th the high-pressure régime was reestablished, causing the fine weather to continue. On the 18th and 19th a rather important depression affected the central zone, causing cloudiness, fog, and drizzle. Then followed another period of good weather from the 20th to the 24th. On the 25th and 26th a large depression crossed the far southern region, causing bad weather and rains in the southern zone. Precipitation exceeded 30 millimeters. Between the 28th and 30th another depression crossed the far south. Rain fell from Aconcagua to Chiloe; 24-hour rainfall up to 50 millimeters was registered. In the southern zone this storm was a violent one.—*Transl. B. M. V.*

METEOROLOGICAL SUMMARY FOR BRAZIL, AUGUST, 1926

By FRANCISCO SOUZA, Acting Director

[Directoria de Meteorologia, Rio de Janeiro]

The secondary circulation during August was less active than in July; the anticyclones moved along less meridional paths but were still very extensive. Four HIGHS invaded southern Brazil, while the continental depression and those of high latitudes were especially active, principally on the 10th, 11th, and 21st, there forming on this latter date over the Argentine littoral in the latitude of Mar del Plata a secondary that produced very strong winds which reached the southern part of Brazil.

Rains in the north were generally scant, averaging 30 millimeters below normal. In the central and southern regions irregular precipitation was observed, which departed little from the normals.

The harvesting of cotton was practically finished; yields in the north did not meet expectations. The coffee harvest is about ended and has produced a normal yield. The yields of cane have been good, and rains in the north favored tillage and the new planting, as they did also in the central region. Tobacco has yielded well, and the new planting is in process.

The weather at Rio was in general good, with little cloud except from the 17th to the 19th and the 23d to the 27th, which were unsettled. The month was mildly warm, though the nights were a little cooler than normal for August. The mean temperature and the mean maximum were slightly above their normals, the mean minimum slightly below. Rains were abundant in the third decade, being 58 millimeters above the normal. Winds were prevailing southerly and of moderate velocity, except that there occurred in the early morning of the 24th a squall from south-southwest which attained a maximum velocity of 19.9 m. p. s. at 12.45 a. m.—*Translation, W. W. R. and B. M. V.*

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING SEPTEMBER, 1926

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1924, 52:42, January, 1925, 53:29, and July, 1925, 53:318.

TABLE 1.—*Solar radiation intensities during September, 1926*

[Gram calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass, A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Sept. 8	11.38			0.61	0.78						12.24
11	7.87		0.90	1.00	1.18	1.41					8.18
15	10.21		0.69	0.86			1.08	0.84	0.69	0.68	10.59
17	15.65		0.37								11.81
Means			0.65	0.82	(0.98)	(1.41)	(1.08)	(0.84)	(0.69)	(0.58)	
Departures			−0.09	−0.05	−0.06	+0.09	+0.03	±0.00	−0.03	−0.08	

MADISON, WIS.

Date	e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e.
Sept. 9	7.29				1.28	1.50	1.28				7.29
10	6.50			1.10	1.27	1.46	1.22				7.04
18	16.79				0.89	1.10					16.79
20	10.21					1.41	1.20				7.87
25	3.99			1.18	1.31	1.46					3.45
Means				(1.14)	1.19	1.39	1.23				
Departures				+0.11	+0.02	+0.01	+0.07				

TABLE 1.—*Solar radiation intensities during September, 1926*—Con.

LINCOLN, NEBR.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass, A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Sept. 6	10.97			1.08	1.18						13.61
9	7.57		1.07	1.20	1.32	1.50	1.25	1.02	0.86		6.27
10	8.81		0.91	1.02	1.20	1.41	1.05	0.97	0.83	0.71	9.83
25	3.63		1.12	1.24	1.38	1.59	1.36	1.21	1.09	1.00	2.74
Means			1.03	1.14	1.27	1.50	1.22	1.07	0.93	(0.86)	
Departures			+0.16	+0.13	+0.08	+0.10	+0.07	+0.09	+0.09	−0.02	

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation: Washington	Madison	Lincoln	Chicago	New York	Average daily departure from normal: Washington	Madison	Lincoln
1926	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Sept. 3	280	288	370	192	270	−112	−88	−67
10	393	289	325	245	404	+20	−60	−86
17	317	282	264	242	244	−43	−45	−126
24	221	209	287	128	142	−126	−97	−83
Deficiency since first of year on Sept. 30						−3,899	−147	−1,897

From Table 1 it is seen that solar radiation intensities averaged slightly below the normal for September at Washington, D. C., and above normal at Madison, Wis., and Lincoln, Nebr. At Lincoln an intensity of 1.48 gram calories per minute per square centimeter measured at 10.30 a. m. of the 25th equals the highest intensity ever measured at that station in September. Throughout the entire day the intensity was very high, and only slightly lower in the afternoon than in the morning. At Madison, an intensity of 1.44 gram-calories at 11.45 a. m. of the 9th is only about 1 per cent less than the previous September maximum.

Table 2 shows a deficiency in the amount of radiation received on a horizontal surface from the sun and sky at all three stations due to excessive cloudiness.

At Washington the polarimeter was out of adjustment during most of the month. A reading obtained on the 8th gave a polarization of skylight of 51 per cent. Measurements made on four days at Madison give a mean of 70 per cent, with a maximum of 72 per cent on the 11th. The maximum is close to the average maximum for September at Madison; the mean is considerably higher than the September mean.

WEATHER OF NORTH ATLANTIC AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. Young

September was marked by an unusual degree of storm activity in tropical regions of the North Atlantic. In addition to the hurricane which devastated Miami on the 18th there were no fewer than four other storms of tropical origin. The hurricane of the 4th–21st was notable both for its length of life and widespread influence on shipping and was also responsible, in all probability, for the loss of two ships, the American steamship *Haleakala*, on the 9th and the British steamship *Loyal Citizen* on the 14th.

The first telegraphic indications of this hurricane to reach the Weather Bureau were received on the 8th and 9th, but reports subsequently received by mail show that it was in existence as early as the 4th. On this date the British steamship *Stornest*, bound from Newport News to Santos, came under its influence and on the early morning of the 5th experienced full hurricane winds. From the latter date it moved on a northwesterly course with diminishing speed and reached a position about 300 miles west of Bermuda on the 14th, whence it began to recurve.

On the 14th the British steamship *Mayaro* was in the calm center of the hurricane from 10.15 a. m. to 4 p. m. In a special report to the Weather Bureau Capt. A. Y. Drysdale states that he was surprised to find the sea within the center so moderate that a small boat could have been used with perfect safety. The atmosphere was "clammy and stuffy" and the weather cleared so that blue sky appeared in patches. Captain Drysdale was able to obtain sights to determine the position of his vessel—31° 49′ N., 69° 11′ W.

On the morning of the 14th, while the hurricane just described was southwest of Bermuda, telegraphic reports reaching the bureau indicated the existence of another disturbance about 200 miles northeast of St. Kitts. This moved rapidly west-northwestward and passed near Turks Island on the afternoon of the 16th. A special observation from that place, the last to be received until October 6, showed a pressure of 29.62 inches and a wind velocity of 100 miles an hour from the northwest.

This hurricane continued to move rapidly and reached the southeastern Florida coast on the morning of the 18th, the center passing directly over the city of Miami, where a Weather Bureau station is located. There was a lull in the wind of about 35 minutes, commencing at 6.45 a. m., and the barometer fell to 27.61 inches, the lowest pressure ever registered at a Weather Bureau station in the United States. Continuing its northwestward movement the hurricane reached the vicinity of Pensacola and Mobile on the morning of the 20th. It dissipated to the northwest of New Orleans on the 22d. An account of this hurricane will appear in the October issue of the Review.

On the 12th, while the first hurricane of the month was still south-southwest of Bermuda, a disturbance appeared near Swan Island, in the western Caribbean Sea, and moved northeastward over Cuba. After pursuing an irregular course and without attaining great intensity it dissipated over the southeastern Gulf of Mexico on the 17th. On the 12th, also, a fourth storm, this one of full hurricane intensity, appeared east of Bermuda, moving in a northeasterly direction. This storm was short lived, reports showing little evidence of its existence after the 13th.

On the 25th a fifth disturbance of tropical origin appeared southwest of the Azores, moving on a northeasterly course. On the 26th the station at Horta reported northerly winds reaching a maximum velocity of 76 miles an hour. By 4 p. m. of that day the center appeared to be somewhat north of the islands, the pressure at Horta having risen from 29.45 to 29.54 inches and the wind shifted to northwest. During the following 24 hours the center appears to have moved westward, or possibly southwestward, and to have increased in intensity. At 4 p. m. on the 27th the pressure at Horta had fallen to 29.18 inches, wind southeast, force 8. At 6 a. m. on the 28th the pressure at Horta was 29.08 inches, wind east-southeast, force 5. After this time conditions gradually moderated. A report from the French steamship *Sinaia*, which was involved in this storm, will be found in the accompanying table.

Table 1.—*Averages, departures, and extremes of atmospheric pressures at sea level, 8 a. m. (75th meridian), North Atlantic Ocean, September, 1926*

Stations	Average pressure	Departure [1]	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	[2] 29.57	([3])	30.12	22d	28.79	27th.
St. Johns, Newfoundland	29.97	−0.03	30.32	7th	29.36	23d.
Nantucket	30.13	+0.09	30.36	15th [4]	29.86	13th.
Hatteras	30.08	+0.05	30.22	24th	29.94	2d.
Key West	29.93	−0.04	30.06	1st	29.50	18th.
New Orleans	29.98	−0.01	30.12	25th [4]	29.50	21st.
Swan Island	29.81	−0.08	29.90	1st	29.70	18th.
Bermuda	30.08	+0.03	30.30	25th	29.92	13th. [4]
Horta, Azores	30.02	−0.14	30.46	4th	29.26	28th.
Lerwick, Shetland Islands	29.88	+0.04	30.22	1st	29.52	12th.
Valencia, Ireland	30.11	+0.12	30.42	22d	29.74	18th.
London	30.11	+0.11	30.44	1st	29.78	12th. [4]

[1] From normals shown on H. O. Pilot Chart based on observations at Greenwich mean noon, or 7 a. m., 75th Meridian.
[2] Mean of 27 observations; three days missing.
[3] No normal established.
[4] And on other dates.

The number of disturbances of extratropical origin was below the normal for September and over the eastern and middle sections of the steamer lanes gales were reported only on from two to three days.

The number of days with fog was not far from the normal over the Grand Banks, but somewhat in excess of normal along the American coast and over the eastern sections of the steamer lanes. Fog was reported on three days in the Straits of Gibraltar.

On the 1st and 2d St. Johns, Newfoundland, was near the center of a depression, although, judging from reports received, moderate weather prevailed over the entire ocean on both of these days. On the 3d this LOW was central near 50° N., 35° W., and moderate westerly gales were reported from the southerly quadrants; it then moved rapidly northeastward, increasing in intensity, and on the 4th moderate to strong southwesterly gales swept over a limited area between the 55th and 60th parallels and the 15th and 20th meridians, while the station at Julianehaab, Greenland, reported a southwesterly wind, force 9, and a barometric reading of 29.22 inches.

On the 3d and 4th northeasterly gales prevailed over the region between Nantucket and the 60th meridian, accompanied by comparatively high barometric readings.

On the 6th there was a well-developed LOW central near 45° N., 43° W., surrounded by a limited storm area, and also a depression over the Shetland Islands. On the 7th the western disturbancea lone appeared on the map, being central near 45° N., 32° W.

On the 8th Belle Isle was near the center of a well-developed LOW, although on that day, as well as the 9th, moderate weather prevailed over the entire ocean, with the exception of the tropical disturbance previously mentioned.

On the 10th the eastern section of the steamer lanes was covered by a depression that afterwards developed into an active disturbance of limited extent. On the 11th the center of this LOW was near 55° N., 25° W., with moderate to strong southerly gales in the westerly quadrants.

Charts VIII to XV cover the period from the 15th to 22d, inclusive, when most unusual conditions prevailed, with three tropical disturbances on the map on one day, while during this period heavy weather was also reported by vessels in the steamer lanes and in the vicinity of the Azores.

On the 23d St. Johns, Newfoundland, was near the center of a LOW that moved northeastward, and on the 24th was about 300 miles east of Belle Isle, with westerly gales near the center and moderate weather over the remainder of the ocean.

On the 26th a secondary LOW was central near 50° N., 30° W., with northerly gales over a limited area in the westerly quadrants.

On the 29th and 30th moderate weather prevailed over the ocean generally, although on the latter date winds of force 7 were reported by vessels in the middle sections of the steamer lanes.

OCEAN GALES AND STORMS, SEPTEMBER, 1926

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Albert Ballin, Ger. S. S.	Southampton.	New York	44 36N.	46 30W.	Sept. 2	9p, Sep. 2	Sept. 3	29.73	SSE	WSW., 9	WNW	SW., 9	WSW.-NW.
Andania, Br. S. S.	New York	Plymouth	40 29N.	73 11W.	2	8p., 2	4	29.92	NE	NE., 7	NNE	NE., 9	Steady.
Rathlin Head, Br. S. S.	Middleborough.	Hampton Roads.	59 00N.	15 30W.	4	7a., 4	6	28.75	S	SW., 10	WSW	—, 12	
Stornest, Br. S. S.	Newport News.	Santos	17 10N.	50 45W.	4	5a., 5	5	29.25	ENE	ESE., 12	SE	ESE., 12	ESE.-S.
La Crescenta, Br. S. S.	Liverpool	Colon	41 58N.	46 58W.	5	11p., 5	6	29.56	NE	NE., 9	N	NE., 10	ENE.-N.
Idaho, Br. S. S.	Antwerp	New York	49 22N.	23 24W.	6	Noon, 7	7	30.13	W	SW., 7	WSW	SW., 8	SW.-WSW.
M. F. Elliott, Am. S. S.	Baytown	Copenhagen	54 40N.	28 00W.	9	4p., 10	11	29.70	NNW	SW., 4	NNW	NNW., 10	SW.-NNW.
Dakarian, Br. S. S.	Liverpool	Kingston	26 42N.	63 48W.	10	8p., 10	11	29.78	SE	SE.,—	SE	SE., 9	Steady.
La Crescenta, Br. S. S.	do	Colon	29 08N.	65 03W.	10	3a., 11	12	29.69	ENE	SE., 10	S	SSE., 11	ENE.-ESE.
Coldbrook, Am. S. S.	Antwerp	New Orleans.	30 47N.	54 00W.	11	7a., 12	13	29.52	ESE	ESE., 12	W	ESE., 12	S.-E.-S.-W.
Amsterdam, Du. S. S.	Rotterdam	Baton Rouge	30 30N.	70 00W.	12	–, 13	14	29.49	E	NNE., 10	NW	NNE., 10	SE.-NNE.-NW.
Mayaro, Br. S. S.	New York	Grenada	31 49N.	69 11W.	13	–, 14	15	28.78	NE	S., 11	SW	NE., 12	E.-S.-SW.
Matura, Br. S. S.	Dominica	New York	19 50N.	63 55W.	14	6a., 15	15	28.82	NW	SW., —	SSE	S., 12	NW.-W.-SW.-SSE.
Youngstown, Am. S. S.	English Channel.	Galveston	33 45N.	67 00W.	15	10p., 15	16	29.29	E	ESE., 7	NW	NNE., 12	E.-NE.
Hilversum, Du. S.	Rotterdam	Montreal	53 57N.	33 45W.	15	Noon, 15	16	29.32	SW	WNW., 8	N	—, 9	
Gedania, Danz. S. S.	Canal Zone	Charleston	19 30N.	75 00W.	16	6p., 16	17	29.54	SW	NNW., 5	SSE	W., 10	
Fort St. George, Br. S. S.	New York	Bermuda	36 35N.	69 08W.	16	5p., 16	17	29.05	NE	SSW., 12	WNW	—, 12	S.-SW.
Lumina, Br. S. S.	Rotterdam	New Orleans	27 40N.	74 45W.	17	4p., 17	18	29.82	SE	SSE., 9	ESE	—, 9	Steady.
Nobles, Am. S. S.	Mediterranean.	New York	35 15N.	63 38W.	17	8p., 17	18	29.75	S	WSW., —	W	WSW., 9	WSW.-W.
Bird City, Am. S. S.	Copenhagen	Baltimore	40 40N.	61 51W.	16	6p., 17	19	29.37	SE	ESE., —	N	—, 12	SE.-SW.-NE.
Middleham Castle, Br. S. S.	Galveston	Havre	47 03N.	21 33W.	17	Noon, 17	18	29.30	SSW	SSW., 8	S	S., 9	NE.-E.-SSW.
Michigan, Fr. S. S.	Havre	Galveston	24 35N.	81 28W.	18	5a., 18	21	29.18	N	N., 10	S	W., 10	
El Oceano, Am. S. S.	New York	do	27 15N.	79 40W.	18	Noon, 18	18	29.62	ENE	E., 8	SE	ENE., 10	E.-ESE.
Concho, Am. S. S.	do	do	29 20N.	80 30W.	17	4a., 18	19	29.76	E	E., 8	E	E., 12	Steady.
Scalaria, Br. S. S.	New Orleans	Hull	37 32N.	60 02W.	18	Mdt., 18	20	29.30	W	SW., 9	SSE	SW., 11	W.-SW.
Albert Ballin, Ger. S. S.	New York	Cherbourg	41 00N.	61 40W.	17	Noon, 18	19	29.18	ENE	NNE., 12	SSE	NNE., 12	N.-NNE.
Martha Washington, Ital. S. S.	Lisbon	New York	41 00N.	68 10W.	17	1p., 18	19	29.70	SE	ENE., 10	NE	ESE., 10	ESE.-E.
Housatonic, Br. S. S.	London	Philadelphia	45 38N.	42 03W.	17	2p., 18	19	28.85	NNW	NNW., 8	NNW	NNW., 9	Steady.
Solitaire, Am. S. S.	Port Arthur	Tampa	26 32N.	87 15W.	19	10a., 19	19	29.53	WNW	WNW., 9	WNW	WNW., 9	NW.-W.
Berlin, Ger. S. S.	New York	Cherbourg	40 50N.	64 10W.	19	Noon, 19	19	29.77	N	NE., 9	E	NNE., 10	NNE.
Cogne, Ital. S. S.	Antwerp	Hampton Roads.	36 46N.	32 43W.	19	4a., 19	19	29.96	W	WNW., 8	NW	WNW., 9	
De La Salle, Fr. S. S.	Houston	Havre	38 28N.	64 14W.	19	4a., 20	21	29.50	N	NNE., —	SE	NNE., 9	NE.-E.
Silverpine, Br. S. S.	Singapore	New York	36 33N.	36 33W.	19	Noon, 20		29.65	NW	WNW., 9		WNW., 9	
Flandre, Fr. S. S.	Bordeaux	Cristobal	40 35N.	17 10W.	20	2p., 20	21	29.53	SE	SE., 8	WNW	SSE., 9	SE.-SW.
Housatonic, Br. S. S.	London	Philadelphia	42 14N.	57 20W.	21	11p., 21	22	29.22	E	N., 12	NNW	N., 12	ENE.-N.
Maine, Dan. S. S.	Copenhagen	Boston	59 30N.	12 10W.	20	4a., 21	21	29.92	S	W., 8	WNW	W., 9	SSW.-W.-WNW.

Ocean gales and storms, September, 1926—Continued

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN—Continued								*Inches*					
Delia Terzo, Ital. S. S.	Dakar	Norfolk	29 49N.	46 03W.	21	3p., 22	23	28.50	S	S., 10		N., 12	S.-N.
Norwegian, Br. S. S.	Havre	do	41 46N.	56 00W.	21	1a., 22	22	28.81	SE	Calm	NW	—, 12	SE.-NW.
Hardenberg, Du. S. S.	Rotterdam	Montreal	53 32N.	45 39W.	23	—, 24	25	29.37	SE	S., 8	SW	S., 8	SE.-S.
Natica, Br. S. S.	Blexen	Curacao	36 17N.	35 25W.	25	6a., 25	25	29.10	E	NNE., 12	N	NNE., 12	
Baron Sempill, Br. S. S.	London	New York	49 20N.	32 00W.	26	4a., 26	26	29.83	N	N., 9	NE	N., 10	
Conte Rosso, Ital. S. S.	New York	Naples	38 23N.	28 00W.	25	5p., 26	26	29.41	NNE	NNE., 9	SW	NNE., 9	
Sinaia, Fr. S. S.	Lisbon	Providence	38 25N.	30 25W.	26	7p., 27	28	28.94	E	NNW., 10	NNE	N., 10	E.-N.-NW.-N.-NNE.
Clontarf, Am. S. S.	New York	Morocco	40 33N.	34 13W.	28	4p., 28	20	29.75	NNE	NNE., 8	NE	NNE., 9	NNE.-N.
NORTH PACIFIC OCEAN													
Steel Ranger, Am. S. S.	Yokohama	Vancouver	49 00N.	175 50W.	Aug. 30	2a., 31st	Sep. 1	29.36	E	N., 9	N	N., 9	NE.-N.
Anomia, Br. S. S.	San Pedro	Yokohama	35 00N.	157 00E.	Sept. 1	2a., 2	2	28.65	SSE	SSW., 12	WNW	SSW., 12	
Indian Arrow, Am. S. S.	San Francisco	Shanghai	32 50N.	157 50E.	1	11p., 1	2	29.79	S	S., 8	W	SW., 9	S.-SW.-W.
Maunawili, Am. S. S.	Honolulu	San Francisco	36 20N.	127 00W.	1	4p., 3	3	29.74	NNE	NNW., 5	NNW	N., 8	N.-NNW.
West Henshaw, Am. S. S.	Siain, P. I.	do	38 20N.	170 30E.	2	8p., 2	2	29.68	S	ESE., 8	SE	ESE., 8	S.-E.
Tahchee, Br. S. S.	Tsurumi	do	43 40N.	179 37E.	2	Noon, 3	3	29.75	SSE	SSE., 8	S	SSE., 8	Steady.
Harold Dollar, Br. S. S.	Columbia River.	Yokohama	44 25N.	159 20E.	2	4p., 2	3	29.32	NW	NW., 5	NW	NW., 11	Steady.
Do	do	do	39 39N.	149 00E.	4	4a., 4	5	29.46	S	S., 6	NW	NW., 11	S.-W.-NW.
Africa Maru, Jap. S. S.	Yokohama	Victoria	49 11N.	175 07W.	2	10p., 2	4	29.50	S	S., 9	S	S., 9	Steady.
City of Vancouver, Br. S. S.	Grays Harbor	Yokohama	50 01N.	170 28E.	3	Noon, 3	4	28.33	ESE	NE., 10	NW	NE., 10	
Juyo Maru, Jap. S. S.	Everett	do	50 22N.	179 44W.	2	10p., 3	5	29.00	S	S	N	S., 10	9 points.
Meiyo Maru, Jap. S. S.	Muroran	Seattle	43 21N.	156 15E.	6	2a., 6	7	29.17	NW	NW., 6	NNW	NNW., 8	
Juyo Maru, Jap. S. S.	Everett	Yokohama	43 22N.	151 50E.	10	3a., 11	11	29.82	SSE	ESE., 4	NE	E., 11	2 points.
Protesilaus, Br. S. S.	Yokohama	Victoria	42 45N.	155 47E.	11	4p., 11	12	29.48	E	ENE., 10	NE	E., 10	E.-ENE.
Akibasan Maru, Jap. S. S.	do	San Francisco	47 48N.	175 15W.	12	8a., 13	15	29.91	SE	SE., 5	SSE	SSE., 8	SE.-SSE.
Koyu Maru, Jap. S. S.	Grays Harbor	Yokohama	50 10N.	172 30E.	12	1a., 15	16	29.21	SE	NNE., 7	W	NW., 9	SE.-E.-NNE.
Kurohime Maru, Jap. S. S.	Yezo	Farallon Isl.	48 50N.	174 43E.	13	5p., 14	15	29.06	ESE	E., 3	SSE	NE., 9	E.-SE.
Clauseus, Am. S. S.	Balboa	San Diego	17 11N.	101 40W.	14	4p., 14	14	29.74	NW			NW., 9	Variable.
Pres. Jefferson, Am. S. S.	Yokohama	Seattle	48 00N.	174 00E.	14	4a., 15	15	28.91	NNW	ENE., 4	SSE	NNW., 9	10 points.
Pres. Monroe, Am. S. S.	New York	San Francisco	18 05N.	103 40W.	15	1a., 16	16	29.72	NW	W., 8	SW	W., 8	
Steel Navigator, Am. S. S.	Balboa	Honolulu	15 59N.	109 35W.	16	2p., 16	16	29.64	SW	WSW., 8	WNW	WSW., 9	WSW.-W.
West Kader, Am. S. S.	Yokohama	Portland	39 52N.	148 50E.	17	2p., 18	18	29.53	NE	E., 7	E	E., 8	E.-NE.
West Chopaka, Am. S. S.	Siain, P. I.	San Francisco	42 51N.	172 04E.	23	Noon, 23	24	29.70	NW	W., 4	NW	NW., 8	Steady.
Benalder, Br. S. S.	Astoria	Panama	21 07N.	108 47W.	24	8p., 24	25	29.66	ENE	E., 7	SE	SE., 10	E.-ESE.
Havre Maru, Jap. S. S.	Muroran	Coos Bay	40 20N.	161 00E.	25	7a., 26	26	29.57	S	S., 10		S., 10	Steady.
El Oso, Br. S. S.	San Pedro	Yokohama	34 00N.	176 44E.	25	Midt., 25	26	29.55	S	WSW., 5	N	N., 9	SW.-NW.
Toco, Br. S. S.	Antofagasta	San Pedro	24 40N.	112 43W.	26	—, 26	26	29.56	SSE	S., 8	SW	S., 8	
West Kader, Am. S. S.	Yokohama	Portland	49 50N.	143 45W.	28	8p., 28	28	29.49	SE	SSW., 7	SSW	SE., 9	
Pres. Grant, Am. S. S.	do	Seattle	50 01N.	157 59W.	27	—, 28	28	29.34	SE	SSW., 6	SSE	SE., 9	6 points.
Ryujin Maru, Jap. S. S.	Otaru	Portland	52 30N.	154 00W.	28	1p., 28	29	29.22	SE	SW., 7	W	ESE., 10	SE.-WSW.
Oridono Maru, Jap. S. S.	Karatsu	Astoria	49 51N.	162 48W.	27	Noon, 28	30	29.28		W., 6		W., 8	
Kureha Maru, Jap. S. S.	Miike	do	50 13N.	148 30W.	27	3a., 30	30	29.23	SE	WSW., 7	WNW	SE., 8	WSW.-WNW
Paris Maru, Jap. S. S.	Yokohama	Seattle	50 02N.	158 15W.	29	8p., 29	30	29.28	SSE	W., 8	W	W., 8	
INDIAN OCEAN													
Weirbank, Br. S. S.	Penang	Suez	13 32N.	53 18E.	Sept. 7	1p., 8	Sep. 8	29.78	SW	S., 6	S	SSW., 8	SSW.-S.
SOUTH PACIFIC OCEAN													
West Nilus, Am. S. S.	San Francisco	Buenos Aires	43 06S.	82 44W.	Sept. 9	6p., 10	Sep. 10	29.43	S	S., 7	SSE	S., 8	
Makura, Br. S. S.	Wellington	Rarotonga	35 32S.	176 11W.	14	9a., 15	15	29.33	NW	N., —	W	N., 11	N.-NW.
Tamaha, Br. S. S.	Port San Luis	Wellington	39 00S.	178 45E.	16	4p., 16	18	29.18	NW	WNW., 8	W	SW., 9	WNW.-SSW.-W.

NORTH PACIFIC OCEAN

By WILLIS E. HURD

The approach of autumn was well illustrated by the pressure averages on the weather map of the North Pacific for September. West of the peninsula of Alaska the Aleutian LOW was now well established, although shallower than the normal. The greatest abnormality in this region was at Kodiak, where the pressure was 30.01 inches, while the average is only 29.70, or the same as that at St. Paul. Several cyclones, or oscillations of the same LOW, were blocked in upper latitudes in their forward movements by a persistent HIGH over the Gulf of Alaska between the 3d and the 26th, for it was not until the latter date that a LOW succeeded in reaching as far east as Juneau. The way now being clear, another cyclone from the western Aleutians came rapidly through, so that at the close of the month a great depression overlay most of the ocean north of the 40th parallel.

The North Pacific HIGH covered its usual position throughout the month and, in general, for most of September extended from the headwaters of the Gulf of Alaska southward and southwestward to Midway Island.

The following table shows the barometric conditions at selected stations:

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level at indicated hours, North Pacific Ocean, September, 1926*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Dutch Harbor [1,4]	29.81	+0.05	30.36	13th	29.06	29th.
St. Paul [1,5]	29.83	+0.13	30.44	12th	29.26	30th.
Kodiak [1]	30.01	+0.31	30.28	5th	29.26	30th.
Midway Island [1,5]	30.00	−0.07	30.04	2d [6]	29.84	14th.
Honolulu [2]	29.98	−0.02	30.08	1st	29.86	18th.
Juneau [2]	30.07	+0.15	30.47	24th	29.46	30th.
Tatoosh Island [2,3]	29.98	−0.03	30.50	24th	29.52	15th.
San Francisco [2,3]	29.91	−0.03	30.07	20th	29.74	1st.
San Diego [2,3]	29.86	−0.02	30.00	12th	29.75	23d.

[1] P. m. observations only.
[2] A. m. and p. m. observations.
[3] Corrected to 24-hour mean.
[4] One day missing.
[5] Two days missing.
[6] And other dates.

In the dearth of cyclones in upper and middle latitudes east of longitude 170° W., very few gales occurred there except during the last few days of the month, and most of those of the 27th to 30th did not exceed 9 in force.

West of the 170th meridian, on the contrary, the period of greatest quiet was that of the 3d decade, while the periods of greatest activity were those of the 1st to the 4th and the 10th to the 15th. On the 3d and 4th gales of varying force up to 11 swept considerable areas along the steamship routes between Japan and 175° W., and on the 11th forces of 10 to 11, with an accompaniment of violent rains qualls, were experienced by vessels between 40° and 45° N., 150° and 160° E.

On the 1st and 2d a severe storm of probable tropical origin was encountered by the British steamer *Anomia*, San Pedro to Yokohama, while near 35° N., 157° E. The gales began from south-southeast at about 9 p. m. of the 1st, pressure 29.21. At 2 a. m. of the 2d the pressure had dropped to its lowest reading, 28.65, and the wind had attained hurricane force from south-southwest. The *Anomia* had been compelled to heave to an hour earlier, and so remained until noon, when the wind had decreased to west-northwest, 5.

A report by the Rev. José Coronas, chief of the Meteorological division of the Philippine Weather Bureau, upon other September typhoons appears elsewhere in this issue of the REVIEW.

Two apparently moderate disturbances of cyclonic character appeared off the coast of Mexico. The first caused fresh to strong gales at sea near Acapulco on the 14th, and south of Manzanillo on the 16th. A west-southwest gale, force 9, was also reported on the 16th by the American steamer *Steel Navigator* while near 16° N., 109½° W., lowest observed pressure 29.64 inches.

A second series of gales swept the coast between Manzanillo and Mazatlan on the 24th and 25th. The depression causing them seems to have moved northward, since on the 26th gales occurred off the lower part of the Peninsula of California. The highest wind force noted was 10 from southeast, by the British steamer *Benalder*, near 21° N., 108¾° W. The lowest observed pressure was 29.56, read on board the British steamer *Toco* on the 26th, in 24° 40′ N., 112° 43′ W. Heavy rains fell during the course of these disturbances.

At Honolulu the total rainfall was 0.70 inch, or 0.58 less than the normal. The prevailing wind continued from the east. The average hourly wind velocity was 8.8 miles, and the maximum velocity was 26 miles from the east on the 24th. Temperatures were close to normal.

Fog decreased greatly in middle and northern latitudes since August, but was observed on scattered dates all along the upper steamship routes, being met with most frequently, on four to six days in the month, over small areas off the central California coast, to the southeast of Dutch Harbor and east of northern Japan.

TYPHOONS AND DEPRESSIONS

FIVE TYPHOONS OVER THE FAR EAST IN SEPTEMBER, 1926

By REV. JOSÉ CORONAS, S. J.

[Weather Bureau, Manila, P. I.]

Aside from two other distant Pacific depressions or typhoons whose tracks are not so definite, we had five well-developed typhoons over the Far East during the last month of September—two over Japan, two over the Babuyan Islands in the Philippines, and one over the China Sea and Indochina.

Two Japan typhoons.—The first of these seems to have developed on September 1 and 2 over the Pacific between the Loochoo and the Bonin Islands. At 6 a. m. of September 3 the center was shown by our weather maps to be east of Oshima in about 133° 15′ longitude E., and 28° 40′ latitude N. moving northward. On the 4th the typhoon traversed Japan, moving northeastward, the position of the center being at 6 a. m. of the 4th and 5th:

September 4, 6 a. m., 134° 30′ longitude E., 34° 15′ latitude N.

September 5, 6 a. m., 148° longitude E., 45° latitude N.

The second Japan typhoon was probably formed on the 11th to 12th about 250 miles east of northern Luzon. It moved Northwest on the 13th, but recurved to north and northeast on the 14th near to the east of Bashi Channel. On the 15th and 16th the typhoon traversed the Loocho Islands moving northeastward, and on the 17th it traversed Japan, keeping the same direction.

The position of the center at 6 a. m. of the 14th to 18th was as follows:

September 14, 6 a. m., 123° 20′ longitude E., 21° 05′ latitude N.

September 15, 6 a. m., 123° 30′ longitude E., 23° 10′ latitude N.

September 16, 6. a. m., 125° 50′ longitude E., 25° latitude N.

September 17, 6 a. m., 132° 15′ longitude E., 30° 40′, latitude N.

September 18, 6 a. m., 139° longitude E., 38° latitude N.

Two Philippine typhoons over the Babuyan Islands.—The first of these typhoons appeared in our weather maps on the 6th near 130° longitude E., between 13° and 14° latitude N. It moved west-northwest on the 6th, northwest on the 7th and north-northwest in the morning of the 8th; it inclined again to west-northwest at noon of the 8th and traversed the Babuyan Islands in the afternoon of the same day; finally, it inclined to north-northwest and north by west on the 9th, traversing the southern part of Formosa Channel on the 10th, and entering China near Amoy during the night of the 10th to 11th.

The steamers *Mayebashi Maru* and *Ethan Allen* were involved in this typhoon, the former near Balintang Channel, with a barometric minimum 746.49 millimeters (29.39 inches) at 4 p. m. of the 9th, and winds from south by west, force 7, and the latter near the southwestern coast of Formosa with the same barometric minimum at 2 a. m. of the 10th, and winds from southeast, force 6.

The position of the center at 6 a. m. of the 8th, 9th, and 10th was as follows:

September 8, 6 a. m., 123° 50′ longitude E., 17° 30′ latitude N.

September 9, 6 a. m., 119° 30′ longitude E., 20° 30′ latitude N.

September 10, 6 a. m., 118° 35′ longitude E., 21° 45′ latitude E.

The second Philippine typhoon was shown by our weather maps at 6 a. m. of the 25th, east of Luzon in about 128° longitude E., between 15° and 16° latitude N. It moved rapidly northwest by west and west-northwest on the 25th and 26th, the center traversing the Babuyan Islands in the morning of the 26th not far from the northern coast of Luzon and passing to the south of Hongkong in the morning of the 27th.[1] The

[1] According to press reports, the typhoon that entered south China on the 27th caused the loss of 2,000 lives and 130 fishing junks in the waters around the Portuguese colony of Macao.—*W. E. H.*

rate of progress of the typhoon from 6 a. m. of the 26th to 6 a. m. of the 27th was 21 miles per hour.

According to the reports published in Manila papers "hundreds of people were rendered homeless and foodless in the islands of Camiguin and Cagayan of the Babuyanes group where strong typhoons passed there recently. All houses except the municipal building in Calayan and all crops were destroyed."

The position of the center at 6 a. m. of the 25th, 26th, and 27th was:

September 25, 6 a. m., 128° 00′ longitude E., 15° 30′ latitude N.

September 26, 6 a. m., 122° 50′ longitude E., 18° 35′ latitude N.

September 27, 6 a. m., 114° 40′ longitude E., 20° 35′ latitude N.

China Sea and Indo-China typhoon.—This typhoon was formed on the 28th over the China Sea about 100 miles west of Luzon. It moved westward, traversing the Paracels on the 29th and reaching the coast of Indochina to the north of Tourane in the early morning of October 1.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

The outstanding features of the month were the severe tropical storm which struck the southeast Florida coast on the early morning of the 18th; the great extremes of temperature—abnormally cold in the Northwest and coincidently therewith abnormally warm in the South and East—and finally the flood-producing rains in Missouri and adjoining States.—*A. J. H.*

CYCLONES AND ANTICYCLONES

By W. P. DAY

Seventeen low-pressure areas were plotted during September, the majority of which were developments over the Plateau and Rocky Mountain regions and moved northeast or east-northeast into Canada. An unusual number of tropical disturbances developed during the month. On the 13th there were four of these west of longitude 50° W.; one, east of the Leeward Islands, which later passed over Miami; a second, east of Bermuda near longitude 53° W.; a third, about 300 miles southwest of Bermuda; and a fourth of slight intensity south of Cuba. The third storm noted had an unusual history. It was first suspected northeast of the Leeward Islands on the 7th, recurved about 250 miles off the middle Atlantic coast on the 16th and turned northeast, only to be forced to make a loop by an intrusion of high pressure in its path between the 18th and 20th, and finally passed over extreme eastern Newfoundland on the 23d with diminished intensity and reached southern Greenland on the 24th. On the 28th a small hurricane passed inland at Vera Cruz, Mexico; another of great intensity was central over the Azores, and there were indications of a disturbance south of Bermuda. This last depression, however, did not develop and had disappeared by the end of the month.

Only eight high-pressure areas were plotted, but practically all of these were cold-air masses from the Canadian interior. The great HIGH of the 23d–28th brought in the first cold wave of the season to the Rocky Mountain region and the Northwestern States.

FREE-AIR SUMMARY

By L. T. SAMUELS

A comparison of Table 1 and Chart III reveals a strikingly close agreement, the negative temperature departures of the North standing in marked contrast to the positive values of the South. This similarity between the surface and free-air departures is now to be expected in view of the increasing period of observations at the aerological stations. The free-air relative humidity departures were practically all positive, as were those of vapor pressure.

The most pronounced departures in the resultant winds occurred at Broken Arrow and Ellendale, where, as indicated in Table 2, an excess of southerly winds prevailed. It is of particular interest in this connection to note the deficiency in the monthly mean free-air temperatures for Ellendale despite the preponderance of southerly winds at that station. The explanation of this apparently lies in the fact that most of the days on which kite flights were made in southerly winds, the latter were associated with the rear sectors of areas of high pressure. That the temperatures under such conditions are relatively low is further indicated by the fact that in every such instance during the month the temperatures were *below* the monthly mean, whereas in every record obtained in southerly winds associated with the front sector of a low-pressure area the free-air temperatures were *above* the monthly mean. This relationship between the temperatures in HIGHS and LOWS is still further illustrated by the kite records of Ellendale for the 20th and 21st, the tabulated data of which appear below:

Altitude m. s. l. (meters)	20th, 7.12 to 9.15 a. m.		21st, 9.54 to 11 a. m.	
	Temperature °C	Wind direction	Temperature °C	Wind direction
444 (surface)	4.7	SSE	16.1	NNW.
500	5.7	SSE	15.7	NNW.
750	10.3	SSE	13.7	N.
1,000	9.8	SSE	13.7	N.
1,250	9.1	SSE	12.9	NNW.
1,500	8.3	SSE	12.4	NW.
2,000	6.9	SSE	10.9	NW.
2,500	8.1	SSE	7.1	W.
3,000	4.6	S	3.2	W.
3,500	1.1	SSW	−0.9	W.
4,000	−2.5	SSW	−5.2	W.

The data for the 20th represents conditions in the rear sector of a HIGH and shows southerly winds prevailing from the ground to 4 kilometers, while the record for the 21st was obtained in the rear sector of a LOW, and in accordance with the pressure gradient under these conditions the winds from the ground to 2 kilometers were mostly northerly. In both cases the velocities were large. It will be seen, however, that with the northerly winds associated with the LOW the temperatures up to 2 kilometers were appreciably *higher* than on the preceding day, when southerly winds prevailed from the rear sector of a HIGH. At 2 kilometers on the 21st where the north component disappeared and the winds became westerly the temperatures became increasingly lower than at the corresponding levels on the 20th. This increase in the lapse rates in the higher levels of LOWS as compared to

that in HIGHS is characteristic of these two pressure systems.

Simultaneous kite flights made at Broken Arrow and Royal Center on the 25th afford excellent illustrations of the free-air conditions in the front sector of an advancing area of high pressure. Both records revealed the coldest air to be between the ground and an elevation slightly more than 1,000 meters. Above this the temperatures at both stations remained relatively high. At Broken Arrow the temperature at 1,755 meters (the maximum altitude) was the same as at the surface, while at Royal Center, where a considerably higher flight was obtained, the temperature at the maximum altitude, 3,665 meters, was only 6° *lower* than that at the surface. Another interesting feature of these records was a rise in the relative humidity to the saturation point *within* the inversion stratum.

TABLE 2.—*Free-air resultant winds (m. p. s.) during September, 1926*

Altitude, m. s. l.	Broken Arrow, Okla. (233 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)				Washington D. C.[1] (34 meters)	
	Mean		9-year mean		Mean		6-year mean		Mean		9-year mean		Mean		8-year mean		Mean		9-year mean		Mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Meters																						
Surface	S. 5°E.	4.9	S.	3.3	N. 70°E.	3.3	N. 61°E.	2.7	S. 89°E.	0.7	W.	0.5	S. 8°E.	2.7	S. 18°E.	1.9	S. 20°W.	1.1	S. 45°W.	1.3	N. 14°E.	1.2
150	S. 5°E.	5.0	S.	3.5	N. 70°E.	3.4	N. 60°E.	2.7					S. 7°E.	3.5	S. 18°E.	2.5	S. 25°W.	1.4	S. 42°W.	1.5	N. 38°E.	1.1
200	S. 1°E.	7.0	S. 8°W.	4.8	N. 65°E.	3.4	N. 55°E.	2.8	S. 71°E.	1.0	S. 71°W.	0.6	S. 4°E.	4.9	S. 10°E.	3.9	S. 47°W.	3.1	S. 46°W.	3.2	N. 40°E.	0.8
550	S. 7°W.	7.7	S. 15°W.	5.4	N. 75°E.	4.2	N. 62°E.	3.4	S. 46°E.	1.5	S. 50°W.	1.4	S. 1°E.	6.2	S. 5°E.	4.3	S. 58°W.	3.7	S. 55°W.	4.2	N. 18°W.	1.3
7,000	S. 16°W.	8.0	S. 25°W.	5.3	N. 78°E.	4.1	N. 69°E.	3.4	S. 30°E.	1.8	S. 53°W.	2.0	S. 6°W.	7.5	S. 2°E.	4.7	S. 61°W.	4.2	S. 64°W.	4.8	N. 36°W.	3.4
1,250	S. 16°W.	7.8	S. 30°W.	5.1	N. 59°E.	3.8	N. 54°E.	3.1	S. 8°W.	3.4	S. 59°W.	2.7	S. 2°W.	8.3	S. 2°E.	4.8	S. 70°W.	5.5	S. 68°W.	5.8		
1,500	S. 21°W.	7.8	S. 39°W.	5.3	N. 58°E.	3.4	N. 56°E.	2.3	S. 20°W.	5.1	S. 66°W.	3.7	S. 3°W.	9.5	S.	4.7	S. 74°W.	7.1	S. 73°W.	6.6	N. 60°W.	5.1
1,000	S. 22°W.	7.0	S. 45°W.	5.8	N. 77°E.	6.9	N. 66°E.	2.0	S. 31°W.	6.8	S. 71°W.	4.9	S. 2°W.	8.4	S. 1°W.	4.3	S. 73°W.	10.6	S. 75°W.	8.5	N. 73°W.	5.8
2,500	S. 27°W.	6.7	S. 53°W.	5.5	N. 67°E.	5.7	N. 67°E.	1.5	S. 46°W.	8.5	S. 77°W.	6.8	S. 1°W.	7.7	S. 3°E.	4.2	S. 75°W.	15.3	S. 75°W.	10.3	N. 74°W.	6.4
2,000	S. 27°W.	7.3	S. 47°W.	6.3	N. 64°E.	2.0	S. 39°E.	0.1	S. 76°W.	12.7	S. 85°W.	9.0	S. 6°W.	7.9	S.	4.2	S. 80°W.	17.8	S. 74°W.	13.0	N. 76°W.	6.7
3,500	S. 28°W.	7.3	S. 51°W.	6.3					S. 79°W.	15.5	S. 86°W.	10.5	S. 5°W.	6.9	S. 3°W.	3.4	W.	20.5	S. 81°W.	12.3	N. 63°W.	6.9
3,000	S. 45°E.	6.9	S. 68°W.	7.3					S. 86°W.	15.1	N. 80°W.	12.1	S. 58°E.	1.5	S.	3.2	W.	20.0	W.	10.9	N. 64°W.	8.8
4,500									S 69°W.	19.6	N. 79°W.	13.2	S. 22°W.	10.0	S. 4°W.	5.4						
4,000									S. 57°W.	21.8	N. 88°W.	14.6										

[1] Naval air station.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during September, 1926*

TEMPERATURE (°C.)

Altitude, m. s. l.	Broken Arrow, Okla. (233 meters)		Due West S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)		Naval air station, D. C. (7 meters)
	Mean	Departure from 9-year mean	Mean	Departure from 6-year mean	Mean	Departure from 9-year mean	Mean	Departure from 8-year mean	Mean	Departure from 9-year mean	Mean
Meters											
Surface	25.3	+1.7	23.8	−0.1	12.2	−2.4	25.9	+1.3	19.5	−1.5	20.8
250	25.2	+1.8	23.5	0.0			24.8	+0.9	19.3	−1.5	19.5
500	23.1	+1.2	21.5	+0.3	12.1	−2.5	22.8	+0.4	17.9	−0.8	18.4
750	21.5	+0.9	20.5	+0.9	11.0	−3.0	21.5	+0.5	17.0	−0.2	17.3
1,000	20.3	+1.0	19.8	+1.3	10.1	−3.0	20.1	+0.3	16.1	+0.3	16.4
1,250	19.3	+1.3	18.2	+0.9	9.8	−2.4	19.0	+0.4	14.9	+0.5	15.6
1,500	18.5	+1.7	16.8	+0.8	9.1	−2.1	17.8	+0.3	14.0	+1.0	14.3
2,000	15.5	+1.3	13.6	+0.3	6.7	−2.0	15.4	+0.2	12.7	+2.2	12.7
2,500	12.4	+1.0	11.8	+1.4	4.5	−1.4	13.2	+0.5	9.8	+2.1	10.7
3,000	9.4	+0.9			1.5	−1.5	10.8	+0.5	7.7	+2.5	8.1
3,500	6.4	+1.0			−0.8	−1.0	7.9	+0.1	5.1	+2.6	5.7
4,000					−3.7	−1.2	6.0	+1.0			3.1
4,500					−6.8	−1.6	2.8	+0.6			
5,000					−10.1	−2.1					

RELATIVE HUMIDITY (%)

Altitude, m. s. l.	Broken Arrow Mean	Broken Arrow Departure	Due West Mean	Due West Departure	Ellendale Mean	Ellendale Departure	Groesbeck Mean	Groesbeck Departure	Royal Center Mean	Royal Center Departure	Naval air station Mean
Surface	71	+3	76	+10	77	+9	76	0	80	+13	82
250	71	+3	76	+10			79	+3	80	+13	83
500	73	+6	77	+8	74	+7	84	+8	82	+15	81
750	74	+8	75	+5	71	+7	83	+8	82	+15	80
1,000	72	+7	76	+6	69	+7	80	+9	79	+13	78
1,250	72	+8	78	+9	63	+4	75	+7	77	+12	75
1,500	66	+5	75	+6	58	+2	71	+6	73	+10	75
2,000	62	+6	81	+15	55	+2	63	+4	65	+7	66
2,500	57	+5	69	+4	52	0	57	+4	70	+15	58
3,000	51	+2			50	−2	49	0	54	+3	53
3,500	50	−1			51	+1	56	+10	43	−3	44
4,000					45	−2	34	−8			38
4,500					57	+12	21	−19			
5,000					59	+16					

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during September, 1926*—Continued

VAPOR PRESSURE (mb.)

Altitude, m. s. l.	Broken Arrow, Okla. (233 meters)		Due West S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)		Naval air station, D. C. (7 meters)
	Mean	Departure from 9-year mean	Mean	Departure from 6-year mean	Mean	Departure from 9-year mean	Mean	Departure from 8-year mean	Mean	Departure from 9-year mean	Mean
Meters											
Surface	23.14	+3.37	22.42	+3.10	11.59	+0.18	25.34	+1.91	18.59	+1.78	20.52
250	23.01	+3.36	22.11	+3.08			24.79	+2.14	18.44	+1.83	19.31
500	21.20	+3.45	19.80	+2.56	11.07	−0.11	23.48	+2.71	17.22	+2.37	17.66
750	19.55	+3.52	18.05	+2.18	9.77	−0.40	21.37	+2.49	16.23	+2.65	16.14
1,000	17.77	+3.15	17.56	+2.77	9.07	−0.18	18.95	+2.24	14.68	+2.32	15.06
1,250	16.38	+3.13	16.66	+3.10	8.07	−0.18	16.42	+1.57	13.31	+2.17	13.66
1,500	14.30	+2.61	15.45	+2.89	6.94	−0.46	14.28	+1.19	11.95	+2.01	12.48
2,000	11.03	+2.12	13.90	+3.59	5.61	−0.40	10.83	+0.63	9.59	+1.84	9.88
2,500	8.10	+1.49	10.99	+2.46	4.69	−0.30	8.37	+0.49	8.15	+2.22	7.38
3,000	5.70	+0.80			3.92	−0.29	6.11	−0.04	5.57	+1.24	5.39
3,500	4.25	+0.28			3.47	0.00	5.55	+0.05	4.11	+1.15	3.47
4,000					2.88	+0.03	2.49	−1.28			2.50
4,500					2.85	+0.54	0.39	−2.70			
5,000					2.37	+0.58					

THE WEATHER ELEMENTS

By P. C. DAY, In Charge of Division

PRESSURE AND WINDS

Three outstanding features marked the weather of September, 1926: The abnormally heavy and frequent rains in the lower Missouri, middle Mississippi, and Ohio Valleys and some nearby localities; the severe West Indian hurricane over southern Florida and adjacent areas from the 17th to 21st; and the unusually early and

damaging cold wave over the northern plateau and thence eastward to the Great Lakes and portions of the Ohio Valley from the 23d to 26th.

Early in the month moderate cyclonic conditions developed in the central valleys, and heavy rains persisted over wide areas from the middle plains eastward to the Atlantic coast during the first week.

From the 8th to 10th a cyclone of rather unimportant dimensions moved from the middle plains to the St. Lawrence Valley, accompanied by heavy precipitation over the middle Mississippi and Ohio Valleys, some unusually heavy falls occurring in portions of Illinois and nearby areas and causing floods of serious proportions. At the same time some unusually heavy rains occurred in southwestern Arizona and elsewhere in the far Southwest.

By the 14th low pressure had overspread the central Plains, and during the following 24 to 48 hours heavy rains again prevailed over much of the territory where precipitation had been heavy a few days previously, adding further to the extent of the flood waters. At the same time unusual conditions existed and were developing in the West Indian and adjacent areas where on the morning of the 16th three distinct storms of hurricane character were in evidence. The principal one of these, attaining great severity, reached the southern Florida coast on the morning of the 18th, and disappeared over eastern Texas by the 23d. A full account of this notable storm, with details concerning loss of life and damage to property, will appear in the October Review.

While no important cyclonic activity except as indicated above was noted during the latter half of the second decade, local rains occurred in the central valleys at intervals and added further to the soil moisture in sections where clear and drying weather was much needed.

At the beginning of the third decade low pressure appeared in the far Northwest, and moving into the northern Rocky Mountain region during the following day or two brought some unusually heavy and early snows. At points in eastern Washington the first snow ever observed in September occurred, and amounts up to 10 or 15 inches were measured at some of the high elevations of Idaho, Montana, and Wyoming. By the morning of the 23d this storm was central over North Dakota, and the area of precipitation extended thence southeastward to the Gulf and into many portions of the States to eastward. As this area advanced eastward, though the lowest pressure was far to the north, rains fell over wide areas, the amounts being particularly heavy in portions of the Ohio Valley and Great Lakes region.

With the passing of this rain area off the Atlantic coast low pressure was developing over the far Southwest and during the 26th and 27th some unusually heavy rains for that region occurred over central and southeastern Arizona. As this storm extended eastward it brought moderate to heavy rains over much of the southern plains, and though the low pressure soon disappeared rain persisted for several days over a considerable area from northern Texas to the middle Mississippi and Ohio Valleys, and thence northeastward.

At the close a storm of some importance had advanced into the middle Rocky Mountain area, and by the 1st of October had moved into the Dakotas and rain had fallen over wide areas, becoming heavy in portions of the upper Mississippi Valley and adjacent regions.

The only anticyclone of the month exerting an important influence on the weather entered the far Northwest on the 23d, with decidedly high pressure for the season, and advanced southeastward to the middle Mississippi Valley by the 26th, attended by freezing temperature from the plains of Washington and Oregon eastward to the Great Lakes and northern portions of Illinois and Indiana, causing much damage to unpicked fruit in the Northwest, and to the eastward to corn and other crops that had failed to mature earlier on account of continued wet and cool weather. From the central Mississippi Valley this anticyclone moved rapidly to New England, losing much of its importance as to lowering temperature, and most eastern districts escaped frost injury at that time.

The average barometric pressure was above the normal over Canada and from Montana eastward and southeastward to the Atlantic coast, and it was below over the remaining portions of the country. The changes from normal were mostly small, save considerably above in the more northeastern districts, and correspondingly low in the middle plateau.

As a rule pressure averages were higher than in August from the Rocky Mountains eastward save over Florida and the middle Gulf coast. In the northeastern districts the average pressure ranged from 0.10 to 0.15 inch higher than in August. Over all portions of Canada and the United States the pressure is normally higher in September than in August, the greatest increase ordinarily occurring in the plateau region.

The prevailing winds between the Rocky and Appalachian Mountains were mainly from southerly points; elsewhere the prevailing directions varied greatly, though chiefly from the northeast over the Atlantic coast States, and from the northwest near the Pacific coast. High winds were not extensive and damage therefrom was not great save in connection with the severe hurricane over southern Florida and adjacent areas. The details of important storms appear at the end of this section.

TEMPERATURE

For the greater part of the month temperatures were moderately high over the more southern sections and corresponding low toward the north, though the daily variations were on the whole rather small, save near the middle of the last decade when changes ranging from 20° to 30° in 24 hours occurred over wide areas in the central and northern districts from the plateau eastward.

The monthly averages were above normal over nearly the entire region from Arizona and Colorado eastward to the Atlantic coast, and it was a particularly warm month in the southern Appalachian region and adjacent portions of the east Gulf and South Atlantic States, where locally nearly every day had temperatures above normal.

Over all northern and far western States the temperature was below normal, and in Montana, Idaho, and the eastern portions of Oregon and Washington it was nearly everywhere the coldest September in 50 years or more. Over much of the far Northwest and in California it was the first month of the year with mean temperature below normal, and in Oregon it was the first month since November, 1925, with average for the entire State below normal. Over the northeastern States, where cool weather began with February, September added another month to an unusually long period of persistent coolness.

The warmer periods were during the first few days over the far Northwest, the Great Plains, Atlantic and Gulf coast States and in the Southwest, and at widely scattered dates over the remaining districts.

Maximum temperatures were slightly above 100° at some point in all southern States except Florida, reaching 117° locally in southern California, 116° in Arizona, and 110° in Texas.

The lowest temperatures were observed mainly from the 23d to 26th, although in a few northeastern and southeastern districts they occurred as early as the 13th or 14th. During the severe cold wave over northern districts from the 23d to 26th the previous records of low temperatures for September were broken nearly everywhere from the eastern portions of Oregon and Washington to the Great Lakes; and in portions of the northern Plateau and northern Rocky Mountain regions the previous minimum records for September were lowered from 5° to as much as 17°. Freezing temperatures occurred at some point in all except the Gulf and South Atlantic States, the lowest observed, −9°, occurring in Wyoming.

PRECIPITATION

September is the first month of the present year with an outstanding excess of precipitation. Probably two-thirds of the country had amounts above the normal, and over large areas in the central valleys the monthly amounts were the greatest ever measured in September and in some localities the greatest in any month. The monthly falls over much of Florida and the southern portions of Georgia, Alabama, and Mississippi were mainly far above the normal, due chiefly to heavy rains attending the passage of the West Indian hurricane over or near those districts from the 17th to 22d. Precipitation was heavy also over much of the Southwest, Arizona having the wettest September of record.

Following a rather wet August in the central valleys and some eastern districts, the nearly continuous rains of September over the greater part of the same region caused local floods of unusual proportions for that month, delayed the ripening and harvesting of crops and the preparation of the soil for fall seeding and otherwise caused large losses, the details of which appear elsewhere.

Over small areas, principally in the Carolinas and Georgia, the month was notably dry, a few places having the least precipitation of record for September. It was a dry month also in central and eastern Texas, in portions of the western plains and generally over California and some nearby States.

SNOWFALL

Considerable snow occurred over the northern Rocky Mountain region and nearby areas about the 23d and 24th, in connection with the advance of the severe cold wave into those regions. Heavy falls were reported locally in the mountains of Idaho, Montana, and Wyoming, and smaller amounts in the mountains further south and near-by foothills and Plains. In a few localities, notably in eastern Washington and northern Texas, it was the first record of snow in September.

RELATIVE HUMIDITY

The relative moisture of the atmosphere was above normal over nearly the entire eastern two-thirds of the country, the humidity percentages being far above normal over the areas having large excesses of precipitation and persistent cloudy weather. In a few far western districts the percentages were less than normal.

SEVERE LOCAL HAIL AND WIND STORMS, SEPTEMBER, 1926

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path, yards [1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Shelby County, Ohio (west-central part).	1	6 p. m.			$2,300	Tornado	Some crop and property damage	Official, U. S. Weather Bureau.
Taylor County, Tex.	1	8 p. m.				Hail	About 10 per cent crop damage	Do.
Pueblo, Colo.	2	4 p. m.				Whirlwind	A large coal shed wrecked and another moved 500 feet away.	Do.
Webster County, Nebr. (central part of).	2	4 p. m.	440		1,300	Hail	Severe damage over path 5 miles long	Do.
Krider, Nebr.	2	5 p. m.	220		50,000	Tornado and hail.	Buildings on several farms wrecked; large trees uprooted; crops badly damaged by hail; 2 persons injured.	Do.
Nemaha County, Kans., in to southern Pawnee County, Nebr.	2	6 p. m.	440		100,000	Tornado	All buildings on several farms completely demolished, on other farms damaged; some livestock killed; crops damaged; several persons injured.	Do.
Sumner, Ill. (near)	2	9 p. m.		1	900	Thunderstorm and rain.	Some damage to crops and other property; a boy killed near Beardstown.	Do.
Taylor County, Iowa	2	9 p. m.				Hail and wind	Crop damage about 25 per cent	Do.
Stratton, Nebr.	3	1.50 a. m.	3 mi.		60,000	Hail	Crops severely damaged; some property damage over path 8 miles long.	Do.
Carlinville, Ill.	3	6:30 p. m.		1		Wind	Tents blown over; minor property damage; 2 persons injured.	Do.
Lincoln, Ill. (south of)	4	5 p. m.			2,500	do	Small buildings damaged over narrow path 5 miles long. Slight crop injury.	Do.
Colorado Springs, Colo.	4	P. m.				Whirlwind and hail.	Trees uprooted; tents and fences blown down; cottages damaged.	Do.
Hardin County, Ohio	4	P. m.			50,000	Tornado	Five large barns demolished; one person severely injured.	Do.
Cimarron County, Okla.	4	3-4.30 p.m.	880			Hail	Considerable crop damage over path 45 miles long.	Do.
Owensboro, Ky., and vicinity	5	P. m.				Wind, rain, and electrical.	Some damage by lightning; trees broken; some electric power trouble.	Inquirer (Owensboro, Ky.)
Harrisburg, Pa.	6					Thunderstorm, rain, and wind.	Much fruit blown from trees; many branches broken.	Official U. S. Weather Bureau.
Furnas County, Nebr. (east part of).	7	6 p. m.	3,520		4,000	Hail and wind	A number of windmills and farm buildings wrecked; trees uprooted; crop damaged.	Do.
Grand Island, Nebr.	7	8.30 p. m.	10 mi.		100	Hail	Slight crop damage; some windows broken	Do.
Hancock County, Iowa	7	10.30 p. m.				Tornado	Several buildings blown down	Do.
Kossuth, Winnebago, and Cerro Gordo Counties, Iowa.	7	11 p. m.				Wind	Several buildings blown down in each county	Do.
Yuma, Ariz.	7					Wind and rain	Buildings and irrigation canals damaged; paving undermined; section of railway track washed out.	Do.
Harrison County, Iowa	8	2 a. m.				Hail	Orchards injured	Do.

[1] "Mi." signifies miles instead of yards.

Severe local hail and wind storms, September, 1926—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Adair County, Iowa	8	2.45 a. m.			$20,000	Wind	Crops and buildings damaged	Official U. S. Weather Bureau.
Hancock County, Iowa	9	11.30 p. m.				Wind	Light and power lines damaged	Do.
Vilas, Wis	11	11 a. m.	1,760		4,000	Heavy hail	Character of damage not reported	Do.
Russell County, Kans	11	6 p. m.			450	Violent wind	Damage chiefly to farm buildings and livestock	Do.
Manti, Utah	11				6,000	Hail	Damage principally to windows, awnings, and autos.	Do.
Dodge City, Kans. (near)	14	6.30 p. m.				Tornado	No damage reported	Do.
Dodge City, Kans	14	7.15 p.m.			500	do	No damage by tornado but some injury to telephone and power lines and buildings by accompanying high wind.	Do.
Cameron, Mo., and vicinity	14	11.30 p. m.			5,000	Wind and rain	Trees broken, buildings damaged and light service suspended.	Do.
Florida (southern and western part) southern Alabama and Mississippi and eastern coast of Louisiana.	18–22			243		Tropical hurricane.	Details of this storm will appear in the October Review.	Do.
Bancroft, Wis	21	5 a. m.	5 mi.			Heavy hail	Slight damage as all crops had been harvested	Do.
Cranwood, Wis	21	P. m.	5 mi.		18,000	do	Damage mainly to cranberry crop	Do.
Wisconsin Rapids, Wis	21	P. m.			10,000	do	do	Do.
Columbiana County, Ohio	23	12.30 p. m.	100	1	30,250	Tornado	Damage principally to property; small crop loss. Three persons injured.	Do.
Clyde (south of) to Huron, Ohio.	23	4–5 p. m.			100,000	do	Many buildings destroyed or damaged; a number of hogs and cattle killed; hundreds of trees blown down.	Do.
Pittsburgh, Pa. (north of)	23					Wind and rain	Trees uprooted; no other damage reported	Do.
Sandersburg, Ky. (near)	24					Heavy hail	Late corn and tobacco damaged over a narrow strip.	Do.
Washington County, Md. (east part of)	25	P. m.				Thundergust	Some trees uprooted, others damaged; a frame building and shed unroofed; chimneys blown over.	Do.
Chinook, Wash	27	6 a. m.			500	Probably tornado.	A shed damaged; trees and fences blown down	Do.
Utica, S. Dak. (5 miles east of)	30	7.30 p. m.				Wind	Damage on two farms	Press Dakotan (Yankton, S. Dak.)
Canton, S. Dak. (south of)	30	9 p. m.				Probably tornado.	Farm buildings wrecked; hogs killed	Do.
Lake Okoboji region, Iowa	30	P. m.				do	Many cottages and a tabernacle demolished	Do.
Pueblo, Colo	30					High wind	Fruit industry suffered considerably	Official, U. S. Weather Bureau.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

This month will long be remembered, not only because of the great hurricane that passed west-northwestward over extreme southern Florida on the 18th, but because of the fact that for the first time, so far as is known, four tropical cyclones—three of hurricane intensity—were in existence at the same time (September 14–16) west of longitude 50° W. However, during the latter half of September, 1893, there were four hurricanes in progress simultaneously over the North Atlantic Ocean between longitudes 28° and 76° W. (See Fig. 66, MONTHLY WEATHER REVIEW Supplement No. 24).

During the period September 5–8 there was a gradual decrease in pressure and a consequent lessening of the trade winds at the stations in the Lesser Antilles, and during the 8th and 9th the wind changed from east to gentle northwest or west at several of these stations. By the morning of the 10th the wind had turned to southerly at San Juan, St. Thomas, and Turks Island, and it was quite evident that a disturbance of tropical origin was advancing northwestward between Porto Rico and Bermuda. This disturbance moved very slowly and it was a week later (September 17) that it recurved to the northeast over the ocean after its center reached a point about 250 miles east of the Virginia Capes. The first winds of hurricane force were reported by the steamship *Calliope* in latitude 29° 20′ N., longitude 67° 20′ W., on the 13th. On the 14th the steamship *Mayaro* steamed through the hurricane center for about 40 miles in about latitude 32° N., and longitude 69° W., barometer 28.78 inches. At 6 p. m. of the 16th the steamship *Fort George*, in latitude 36° 30′ N., longitude 69° 10′ W., reported a barometer reading of 29.04 inches and a wind of force 12, Beaufort Scale, from the southwest. After recurving, this storm moved rapidly east-northeastward, its center passing about 300 miles south of Sable Island on the 18th. Advisory warnings were issued in connection with this storm daily, and for a few days twice daily. At 12 noon of the 15th northeast storm warnings were ordered displayed from Cape Hatteras to the Virginia Capes, and at 10 p. m. of the same date north of the Virginia Capes to Nantucket, Mass. The next morning the warnings were extended northward to Eastport, Me. Because of the sharp recurve of the storm center toward the east-northeast, the only winds of verifying velocity at coast stations were 42 miles an hour from the northeast at Nantucket, and 50 miles from the same direction at Highland Light.

During the 12th, another tropical disturbance of hurricane intensity was central almost directly east of Bermuda in longitude 56°, moving northeastward.

At 8 a. m. of the 12th the wind at Swan Island was from the south and vessel reports showed a wind circulation around a center a short distance north of Swan Island, and an advisory warning to that effect was issued at 10.15 a. m. The disturbance, still of slight intensity, passed northeastward over west-central Cuba the evening of the 13th. After leaving Cuba there was a considerable increase in intensity, as shown by the a. m. report of the 15th from Nassau, Bahamas, which showed a barometer reading of 29.64 inches and a wind velocity of 42 miles an hour from the northeast. The northeastward progress of the disturbance was blocked about this time and it was forced toward the west. It passed through the Florida Straits the night of the 16th–17th and dissipated the next day over the extreme southeastern Gulf of Mexico.

A more or less complete history of the great Florida hurricane of September 18–20, together with the warnings issued in connection therewith, will be published in the October, 1926, issue of the REVIEW.—*C. L. Mitchell.*

CHICAGO FORECAST DISTRICT

Two outstanding features marked the month's weather: Unprecedented amounts of rain over large areas, principally in the southern half, and a cool wave that caused either the lowest or near the lowest temperatures of record for so early in the season, over most of the district. The heavy rains caused floods in many sections, while frosts damaged late crops. The bulk of the staple crops had matured, however, so that general production was relatively little affected by frost.

Frost warnings for some northwestern sections were issued on the 8th, 9th, 11th, 12th, 13th, and from the 16th to the 21st, inclusive. The cool wave already mentioned was notable for so early in the season. On the night of the 24th–25th heavy-to-killing frost occurred southward and eastward across northern Kansas, most of Iowa, and western Wisconsin, while on the succeeding night it extended across most of Michigan and the northern portions of Illinois and Indiana. Thus, either heavy or killing frost visited the whole district at this time, except southern Kansas, central and southern Missouri, southern Illinois, and extreme southern Indiana. As a result of the widespread dissemination of warnings, in which radio broadcasting took a conspicuous part, much seed corn was saved in Iowa.

No severe storms visited the Great Lakes, but conditions called for either small-craft or storm warnings on a number of occasions. The most general storm warnings were issued on the 8th, 21st, and 23d. In most cases the disturbances lost force as they reached or crossed the Lakes.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

No storm occurred on the west Gulf coast except that the southeast portion of Louisiana came under the influence of the left portion of the tropical storm of September 18–21, for which timely warnings were issued.

Small-craft warnings were displayed for increasing northerly winds on the Texas coast on the 25th. Frost warnings were issued on the 25th for the extreme northern portion of the district. Cloudy weather prevented frost, but freezing occurred in the extreme northwest portion of the district.—*I. M. Cline.*

DENVER FORECAST DISTRICT

An unusual number of disturbances moved eastward from the Plateau Region and Arizona, and frequent LOWS also advanced during the middle and last of the month from the coasts of British Columbia and Washington. Pressures over Alaska and western Canada were generally high during the first 25 days.

As a result of these pressure conditions, cold, stormy weather prevailed in the northern portion of the district. Heavy rains also fell in New Mexico and Arizona on the 25th, 26th, and 27th. A storm that advanced southeastward from British Columbia and crossed Montana and Wyoming on the 21st and 22d brought snow in Montana on the 22d and 23d and in northern Wyoming on the 23d. This disturbance was followed by an area of decidedly high pressure and severely low temperature. Thermometer readings of 6° F. and 7° F. were observed in western Montana and Yellowstone Park on the 24th, and of 9° to 19° in Wyoming on the morning of the 25th, freezing weather on the 25th extending southward to southern Utah and extreme southern Colorado. The 24-hour falls in temperature were hardly sufficient to justify cold wave warnings, although warnings of freezing temperatures were issued for northern Montana on the morning of the 22d, Montana and northern and western Wyoming on the 23d, and Utah and Colorado on the 24th, with warning of temperatures decidedly below freezing issued on the 23d for Montana and on the 24th for eastern Colorado.

Numerous frost warnings were issued during the first half of the month, and frequent frost and freezing temperature warnings during the period from the 16th to the 30th. These were generally verified.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT

The month of September in the far western States was characterized by frequent and pronounced changes in temperature and generally dry weather, except in the Pacific Northwestern States, where rains occurred on a number of days. No storm of sufficient intensity to require warnings occurred. The notable occurrence during the month was the cold weather of the 24th to 26th in Nevada, Idaho, Washington, and Oregon. This period gave freezing temperature throughout these States, except over the extreme western parts of Washington and Oregon, and required forecasts of frosts and freezing temperatures. At points in eastern Washington and eastern Oregon the lowest September temperatures of record were recorded. Following this cold wave the barometric pressure increased decidedly over the interior, including British Columbia and Alberta, Canada, the winds in the Pacific States became north to east, and the humidity decreased to very low readings. Previous to the occurrence of the low humidity, fire-weather warnings were disseminated throughout Washington, Oregon, and California. The conditions that followed gave a period of very high forest-fire hazard in these States. In California a number of large fires occurred in the Sierra and were not extinguished until rains occurred on the first of October. On the 30th of the month when a radical change in the pressure distribution was taking place over the northeast Pacific Ocean, rain warnings were issued for northern and central California for the benefit of those who had fruit sundrying on trays. The rains on October 1 were general over northern California, but, due to the rain warnings, damage to drying fruit was negligible.—*E. H. Bowie.*

RIVERS AND FLOODS

By R. E. SPENCER

Besides rises of varying importance in the middle Mississippi and several other streams of the Middle West, disastrous floods occurred during September in the Neosho, Floyd, Illinois, and Wabash Rivers, and the Grand River of Missouri. Of these latter the first two will be discussed in this report, and those in the Illinois, Wabash, and Grand, the first two of which persisted with pronounced damage into October, will be reported on in full in the October number of this REVIEW.

Rains at least partially contributory to the September floods (except those of northwest Iowa) began falling in the second week of August, so that the ground was already saturated when the heavy falls of early September set in. These continued generally from the 1st to the 6th, and moderate to excessive falls occurred on the 8th and 9th, the 12th to the 16th, the 19th and 20th, and following the

22d, reaching totals far in excess of the normal amounts. Detailed precipitation data covering the Middle West will be published with the October report.

Neosho, Verdigris, and Cottonwood Rivers.—Two floods occurred in the Neosho, the first on the 7th below Iola, Kans., and the second following the 12th along the entire river above the Kansas-Oklahoma line, including the Cottonwood, and also in the Verdigris. In the first and less important rise, which was well forecast, the losses amounted to $15,300 in crops, $600 in livestock and $500 in real property, while a saving of $5,000 was effected through the Weather Bureau warnings. Of the second flood (12th to 22d) the official in charge at Fort Smith reports, "It was the worst flood in the history of the area affected because of the record stages and because of its coming in the season of mature crops." The rise, both in the Neosho and Verdigris, was remarkably sudden, as the rain which caused it fell directly over or near the streams and was thus productive of immediate maximum effect. The rain began early on the morning of the 12th and was excessive from the beginning. Warnings were issued immediately. The Cottonwood River at Emporia rose from 11 feet at 8 a. m. of the 12th to the crest of 29.9 feet, 9.9 feet above flood stage, at 3 p. m. on the 13th; at LeRoy, where the heaviest and fastest rains occurred, the rise started with the beginning of rain in the early morning of the 12th, reaching a crest of 29.6 feet, 5.6 feet above flood stage, at 3 p. m. the same day; at Iola a rise started at about 5 a. m. of the 12th and a crest of 22.1 feet, 7.1 feet above flood stage, was reached at 11 a. m. of the 13th. The rise at Oswego was much slower; this station was below the area of heavy rainfall and the crest of 25.1, 8.1 feet above flood stage, was not reached until the 19th. The stages of 29.9 at Emporia and 29.6 at LeRoy are record stages for those stations.

The rapidity with which the stream rose because of the immediate effectiveness of the rainfall, and at which the crests receded after leaving the area of excessive rainfall are equally noteworthy. The suddenness of the rise rendered impossible the issue of warnings very long in advance, although it is a conservative estimate that those issued effected a saving of $500,000. Of the losses the official in charge at Fort Smith reports as follows:

Four lives were lost during the flood, three from drowning and one from shock. It is estimated that 100,000 acres of land were overflowed causing a crop loss of $2,500,000. Losses of all kinds, including crops, were at least $5,000,000, and more according to some estimates received. Half of this total was due to erosion of land and losses of buildings, improvements, bridges, and to suspension and disorganization of business.

Topeka and Wichita districts.—Two other rises in eastern Kansas for which reports have been received were as follows: In Walnut Creek, which enters the Arkansas River just below Great Bend, an unusual and damaging rise occurred as a result of severe local rainfall. The resulting damage was about $250 to highways, $10,000 to crops and $1,000 to prospective crop on 100 acres of alfalfa land. An overflow along the Kansas River resulted in a loss of $22,000, of which $20,000 was in crops and $2,000 in damage to buildings, highways and bridges.

Floyd and Big Sioux Rivers of Iowa.—This flood was the result of an extremely heavy 15-hour rainfall, which began in the afternoon of September 17, over the five northwest Iowa counties. The area of maximum rainfall, which was about 15 miles wide and in which the average depth was 10 inches, covered the central portion of Sioux County, extending from near Hawarden northeastward about 35 miles, so that the north-south divide between the basins of the Floyd and Big Sioux split the area almost in two. This division of distribution of the rain was doubtless very fortunate, reducing by half as it did the drainage required of either stream; but even so the damage done was remarkably great for a flood of such limited extent and duration. On this point Mr. G. K. Greening, in charge of the Weather Bureau office at Sioux City, Iowa, reports as follows:

Six lives were lost and the reported property damage over the flooded area in Sioux County and the lowlands below on the Big Sioux and Floyd Rivers and tributaries alone amounted to $1,412,252. In Hawarden, Iowa, at the confluence of the Big Sioux River and Dry Creek, a small stream that drains a portion of the area of terrific rains, property valued at $275,000 was destroyed; 350 houses and buildings were flooded, 3 bridges were destroyed, and 5,000 square yards of pavement were made worthless. Valuable farm land along the Big Sioux and Floyd Rivers and tributaries in Sioux, O'Brien, Plymouth, and Woodbury Counties was inundated and crop damage and loss of livestock was estimated at $90,000. In Sioux City 600 homes in the Floyd bottoms were flooded and reported property damage amounted to $246,710. The damage to bridges, highways, telegraph and telephone lines and interruptions to railroads by washouts far exceeded any other flood over the stricken area. The extent of the area overflowed is estimated at 50,000 acres.

In spite of the suddenness of the rise, an effective distribution of warnings was accomplished. The value of the proper cooperation of municipal agencies in this connection is well illustrated in the following extract from Mr. Greening's report:

Warnings.—Flood warnings were issued for the Floyd River lowlands from Merrill to Leeds, Iowa, as early as 7 a. m., September 18 and at noon a general flood warning was given for the bottoms in Sioux City, when alarming reports were received from Merrill and Hinton, Iowa. No effort was spared to arouse the inhabitants to the seriousness of the situation. City officials were alert to the needs and early in the afternoon all of the available boats were moved to the Floyd River banks. Many people living along the river appeared to consider this an unnecessary precaution, but a few hours later the boats were seen to be invaluable.

The precautions that were taken probably saved a number of lives. Police and firemen went from house to house and warned the people. Moving vans were placed at their disposal merely for the asking. The Service Company whistles were blown at 15-minute intervals and thousands of people visited the section of the city late in the afternoon and evening where the flood was expected to strike, so general had the distribution of the warnings been. Yet most of the victims of the flood awaited its arrival before making ready to move. However, business houses heeded the warning and took precautionary measures, and as a result property within the city valued at $85,650 was saved.

The saving effected outside the city totaled $100,290.

Raccoon River.—The flood in the Raccoon River of Iowa was characterized by the same suddenness and concentrated destruction as that of other floods in this State following the heavy rains of September 18. The greatest damage in this, as in the other cases, was to prospective crops. The reported losses are listed as follows:

To prospective crops, mostly corn, damaged but not totally destroyed, 10,000 acres	$60, 000
Livestock and other movable property	10, 000
Losses to bridges and highways	10, 000
Loss by suspension of business, including wages	20, 000
Money value of property saved by warnings	10, 000

Hannibal, Mo., district.—In this district greater damage was done by overflows in the smaller rivers and creeks than by the floods in the Des Moines River. The following extract from the report of the official in charge of the Weather Bureau office at Hannibal indicates the type and extent of the damage.

The losses in the Des Moines valley are estimated as follows: To growing crops, $10,000 to $15,000. The damage by creeks and small rivers to roads and bridges was $20,000 in Wapello County

and probably nearly as much in four other counties in that vicinity.

Skunk River in Iowa was in flood twice during the month. It caused the breaking of the levee of the Green Bay levee district and the flooding of 4,000 acres, mostly in cultivation, and an estimated loss to growing crops of $150,000.

A creek levee broke at New Canton, Ill., causing $20,000 damages to tangible property and $250,000 to growing crops.

The damage to growing crops in Salt River Valley is estimated at $100,000.

At Hannibal the flood in Bear Creek on September 4 caused a damage of $2,000 to $3,000, and it probably cost another $1,000 to clean and repair property.

The rains of 3d–4th caused about $20,000 damage to city streets, $60,000 to the highways and bridges in Marion County, and about $40,000 to highways and bridges in Ralls County.

Reported railroad losses due to washouts amounted to $2,250.

Ohio and Indiana.—Except for the flood in the Wabash (to be reported on in the October REVIEW), no serious rise occurred in these States in September. In the Dayton, Ohio, district some damage occurred through overflows from creeks and small streams, but flood stages were not reached at Weather Bureau river stations. The nearest approach was at Sidney, Ohio, where, as reported by the official in charge at Dayton, "on the 4th and 5th, 3.93 inches of rain fell. The river rose rapidly, but the Conservancy district dams functioned and no damage resulted." The Maumee River was above flood stage at Fort Wayne, Ind., from the 24th until the 27th. This is the first time in the history of the station that flood stage has been reached in this month. Some bottom lands and basements were flooded but no damage of consequence was reported.

Pennsylvania.—A noteworthy instance of the effect on mountain streams of sudden heavy rain is reported by the official in charge of the Weather Bureau office at Scranton, Pa. Heavy thunderstorms occurred on the night of the 5th–6th in southwest Susquehanna County, Pa. The report on conditions following the rain reads:

> * * * The waters, rushing down the mountain sides, filled the gullies and ravines with torrents laden with logs and rocks. These streams, pouring into the valleys, swept through three villages—Harford, Kingsley, and Hopbottom—which are located on the smaller tributaries of the Susquehanna River. The first floors of buildings were flooded, furniture washed into the streets, buildings battered by logs and rocks, and fields, gardens, and highways washed out. Kingsley and Hopbottom are on the Lackawanna Trail and portions of the concrete highways were undermined and torn out. No lives were lost but the property loss was heavy, probably amounting to $50,000, including damage to highways and bridges.

Texas.—In this State floods were not severe and were well forecast. The only reported loss was highway damage amounting to $5,000 along the Trinity River.

Arizona.—The flood in southeastern Arizona during the latter part of the month is reported on by the official in charge at Phoenix as follows:

> * * * Unusually heavy rains in southeastern Arizona from September 25 to 27, inclusive, resulted in marked rises in streams draining that section. During the night of 26th–27th a stage of 6 feet was reached at Kelvin, on the Gila River; at 9.30 a. m. of the 28th a stage of 9.5 feet was reported, and the crest of the rise, 16 feet, 11 feet above the flood stage, was reached at 10 p. m. of the 28th. The stage declined rapidly thereafter reaching 7 feet at 8 a. m. the 29th and dropping below flood stage by the morning of the 30th. The major damage occurred along small tributaries in the immediate vicinity of the heavy rainfall, the property suffering most being railway tracks, bridges, highways and approaches to highway bridges. Railroad damage was estimated at $375,000, state highways at about $60,000, and damage to the military post at Camp Little, Ariz., at $12,000. It is thought that little damage occurred below Kelvin, where the increased width of the river caused the crest to flatten out considerably in its downward course.

Following is a table, by districts, of losses and savings in the floods discussed above. The figures are necessarily very incomplete and partly estimated.

District	Lives	Tangible property	Farm losses	Suspension of business	Total losses	Savings by warnings
Fort Smith, Ark.	4		$2,515,900		$5,000,000	$505,000
Topeka and Wichita, Kans.		$2,250	31,000		33,250	
Sioux City, Iowa	6	1,275,052	91,700	$45,500	1,412,252	185,940
Des Moines, Iowa		10,000	70,000	20,000	100,000	10,000
Hannibal, Mo.		146,250	515,000		661,250	
Scranton, Pa.		50,000			50,000	
Dallas, Tex.		5,000			5,000	
Phoenix, Ariz.		447,000			447,000	
Totals	10	1,935,552	3,223,600	65,500	7,708,752	700,940

River and station	Flood stage	Above flood stages—dates: From—	To—	Crest: Stage	Date
GREAT LAKES DRAINAGE	Feet			Feet	
Maumee: Fort Wayne, Ind.	15	24	27	17.0	24
MISSISSIPPI DRAINAGE					
Shenango: Sharon, Pa.	9	26	27	9.2	26
Tuscarawas:					
Gnadenhutten, Ohio	9	6	8	10.3	7
		24	28	13.8	26
Coshocton, Ohio	8	24	25	9.4	24
Walhonding: Walhonding, Ohio	8	24	24	8.8	24
Scioto:					
Larue, Ohio	11	5	7	12.9	5
		10	10	11.1	10
Prospect, Ohio	10	7	8	10.4	7
Wabash:					
La Fayette, Ind.	11	5		16.0	8
		26		16.5	28
Terre Haute, Ind.	16	8	17	20.7	12
		30	[1]		
Vincennes, Ind.	14	12		17.7	17–18
Mount Carmel, Ill.	16	12	24	21.5	20
Tippecanoe: Norway, Ind.	6	1	2	6.0	1–2
		14	21	6.4	16–17
		25	[1]	6.5	26 and 30
White: Decker, Ind.	18	17	22	21.6	19
White, East Fork: Seymour, Ind.	10	11	13	11.4	13
White, West Fork:					
Anderson, Ind.	12	6	7	12.8	7
		10	11	14.0	10
Noblesville, Ind.	14	11		14.4	11
		26	26	14.3	26
Elliston, Ind.	19	8	17	27.4	13
Edwardsport, Ind.	15	8	20	19.95	15
Mississippi:					
Quincy, Ill.	14	17	17	14.1	17
		26	30	14.8	28
Hannibal, Mo.	13	5	5	13.2	5
		9	11	14.2	10
		16	19	14.4	17
		25	[1]	14.9	28
Louisiana, Mo.	12	5	12	13.9	11
		17	20	13.4	18
		26	[1]	14.0	29
Grafton, Ill.	18	10	13	18.8	12
		19	21	18.5	20
		27	[1]	19.5	30
Alton, Ill.	21	29	[1]	21.3	30
Des Moines:					
Tracy, Iowa	15	23	25	16.3	24
Ottumwa, Iowa	10	22	26	12.3	25
Raccoon: Van Meter, Iowa	13	19	23	18.8	20
Skunk: Augusta, Iowa	15		11	17.4	9
		15	18	19.9	16
		27	30	16.9	29
Illinois:					
Morris, Ill.	13	24	30	14.0	25
Peru, Ill.	14	4	[1]		
Henry, Ill.	10	9	[1]		
Peoria, Ill.	18	15	[1]		
Havana, Ill.	14	4	[1]		
Beardstown, Ill.	14	5	[1]		
Pearl, Ill.	12	5	[1]		
Floyd: Merrill, Iowa	13			20.0	18
Solomon: Beloit, Kans.	18	15	18	27.4	17
Grand:					
Gallatin, Mo.	20	4	5	24.9	5
		10	10	21.8	10
		15	22	37.0	18
Chillicothe, Mo.	18	4	25	30.3	19
Brunswick, Mo.	12	20	27	14.6	23
Grand, Thompsons Fork: Trenton, Mo.	20	15	18	23.5	17
Neosho:					
Neosho Rapids, Kans.	22	13	15	24.6	14
Le Roy, Kans.	24	12	17	29.6	12

[1] Continued at end of month.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI DRAINAGE—continued					
Neosho—Continued.	Feet			Feet	
Iola, Kans.	15	12	18	22.1	13
Oswego, Kans.	17	7	7	17.5	7
		15	22	25.1	19
Fort Gibson, Okla.	22	7	7	23.5	7
Cottonwood: Emporia, Kans.	20	12		29.9	13
Canadian: Logan, N. Mex.	4			5.0	7
Sulphur: Ringo Crossing, Tex.	20	8	9	21.0	8
WEST GULF DRAINAGE					
Trinity:					
Dallas, Tex.	25	7	9	29.6	7
Trinidad, Tex.	28	10	13	30.3	12
PACIFIC DRAINAGE					
Gila: Kelvin, Ariz.	5	27	29	16.0	28

MEAN LAKE LEVELS DURING SEPTEMBER, 1926

By UNITED STATES LAKE SURVEY

[Detroit, Mich., October 5, 1926]

The following data are reported in the Notice to Mariners of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during September, 1926:	Feet	Feet	Feet	Feet
Above mean sea level at New York	601.30	578.51	571.43	244.86
Above or below—				
Mean stage of August, 1926	+0.32	−0.08	+0.13	−0.13
Mean stage of September, 1925	−0.15	+0.29	+0.50	+0.30
Average stage for September, last 10 years	−1.18	−1.83	−0.77	−1.02
Highest recorded September, stage	−2.78	−4.92	−2.51	−2.75
Lowest recorded September, stage	−0.15	+0.29	+0.50	+0.86
Average departure (since 1860) of the September level from the August level	+0.05	−0.20	−0.26	−0.40

[1] Lake St. Clair's level: In Sept., 1926, 547.01 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, SEPTEMBER, 1926

By J. B. KINCER

General summary.—Over a considerable area extending from the Ohio and extreme lower Missouri Valleys northward, frequent rains and cloudy weather were unfavorable for farming operations and for maturing fall crops, as the soil was usually too wet for proper working. There was also considerable delay in harvesting crops and in late threshing, with complaint of root crops rotting.

In the South, the generally warm weather and light to moderate rain made favorable conditions, except that soil moisture was insufficient for minor crops in the south Atlantic section and some Gulf districts. Except for wet soil and flooding in some eastern districts of the central plains States, conditions were generally favorable throughout the plains area and also west of the Rocky Mountains, wherever it was not too dry. Rain was badly needed in parts of the Great Basin, and there was insufficient moisture locally in the Pacific Northwest.

Crops suffered heavy loss in a limited area in extreme southern Florida and some extreme southern sections along the east Gulf coast by the severe hurricane of the 18th–20th. The greatest loss in southern Florida was to citrus fruit (chiefly grapefruit) and in other sections to open cotton. A detailed description of this storm will appear in the October REVIEW.

Heavy-to-killing frost damaged late crops over a considerable area of the Northwest during the latter part of the month. Late vegetation and immature corn suffered considerably over a belt extending from Michigan, northwestern Illinois, extreme northern Missouri, and northwestern Kansas northward, but in much the greater part of this area the bulk of staple crops had matured, and damage from a general production standpoint was comparatively small. No other material frost damage occurred, as harmful temperatures did not extend into the interior valley States.

Small grains.—Frequent rains and continued wet soil were unfavorable for the preparation of seed beds and for the seeding of winter wheat quite generally from the lower Missouri and upper Mississippi Valleys eastward to the Appalachian Mountain districts. At the close of the month wheat seeding had become considerably delayed in this area. South of the Ohio River, and quite generally throughout the Great Plains, conditions were much better and seeding made favorable progress in these sections. Wheat needed more moisture, however, in the west-central plains, especially in western Kansas, and it was too dry in parts of the Southeast, as well as in some far northwestern districts. The freeze damaged late flax in the northern Great Plains, but most of the crop had matured previously. The harvest of rice advanced satisfactorily with favorable weather, while grain sorghums in the lower Great Plains were mostly mature at the close of the month.

Corn.—The mostly cool, wet, and cloudy weather over the northern half of the country east of the Great Plains was decidedly unfavorable for maturing corn. The crop ripened very slowly, only about one-fourth of it being safe from frost in the upper Mississippi Valley by the middle of September. In the Great Plains area and generally throughout the South maturity was more rapid with better drying weather prevailing. Frost damaged late corn considerably in parts of the Northwest about the 25th, the damaging temperatures extending as far east as the western Lake region. Most of the crop in this area had matured, however, and no widespread serious harm occurred, except through lowering of grade. Elsewhere in the principal corn sections the temperature did not go low enough to be harmful.

Cotton.—The persistently warm weather and mostly light to moderate rainfall were favorable for the cotton crop in most sections, though part of the month was too cloudy and wet in the northern portion of the belt west of the Mississippi River. In most districts the warm and generally sunshiny weather favored rapid opening of bolls, and also good progress of the harvest.

Miscellaneous crops.—In the far Southwest sufficient rain fell to benefit the range materially but in the Great Basin the continued drought was detrimental. In the central and eastern portions of the country meadows and pastures continued generally good for the season, though grass lands needed more moisture in southeastern districts. Potatoes were damaged somewhat by frost in the western Lake region, and wet weather interfered with harvest to a considerable extent in the Ohio Valley; elsewhere conditions were generally favorable. Sugar cane made fair to good progress in Louisiana, and the weather was mostly favorable for sugar beets. Apples and other fruits suffered considerable damage from freezing weather in the far Northwest.

CLIMATOLOGICAL TABLES [1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, September, 1926

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	79.4	+4.0	Brewton	99	[2] 4	Riverton	54	26	5.50	+2.23	Bay Minette	19.70	Winfield	0.10
Arizona	74.3	+1.2	Mohawk	116	1	Bright Angel Ranger Station.	24	19	2.71	+1.66	Bisbee	10.19	Parker	0.04
Arkansas	76.8	+2.6	Pine Bluff	101	13	Lurton	40	26	3.99	+0.56	Lurton	14.55	Arkansas City	0.27
California	65.4	−2.2	Greenland Ranch	117	15	Helm Creek	12	29	0.05	−0.50	Crescent City	1.55	151 stations	0.00
Colorado	57.0	−0.1	Lamar	103	21	2 stations	6	[2] 24	0.99	−0.40	Rico	3.86	4 stations	0.00
Florida	80.9	+1.5	3 stations	98	[2] 1	Mount Pleasant	61	13	7.93	+1.73	Blountstown	21.23	Madison	1.80
Georgia	78.8	+3.5	do	101	1	Clayton	50	[2] 26	3.64	+0.17	Thomasville	9.43	Lisbon	0.34
Idaho	52.3	−4.8	2 stations	95	5	Obsidian	−1	24	1.03	−0.02	Pocatello	2.60	7 stations	0.00
Illinois	67.7	+0.3	Harrisburg	97	16	Mount Carroll	25	26	9.42	+5.84	Griggsville	16.83	Harrisburg	1.71
Indiana	68.0	+1.0	Washington	98	22	Howe	29	26	8.17	+5.05	Nobelsville	14.58	Mount Vernon	1.96
Iowa	63.0	−1.3	5 stations	92	[2] 1	Decorah	18	26	9.76	+6.11	Corydon	18.57	Mason City	4.75
Kansas	69.2	−0.3	Bison	106	1	2 stations	18	25	4.81	+2.08	Le Roy	20.10	Irene	0.07
Kentucky	73.5	+3.2	Murray	98	17	Scott	40	26	3.80	+0.99	Quicksand	7.31	Pikeville	1.18
Louisiana	80.9	+3.2	Dodson	103	13	Lake Providence	47	26	3.08	−0.92	Franklin	11.67	Tallulah	0.06
Maryland-Delaware	67.9	+0.4	2 stations	93	[2] 2	Grantsville, Md	35	11	5.00	+1.74	Chewsville, Md	7.51	Millsboro, Del	2.11
Michigan	58.5	−1.4	Midland	90	1	Roscommon	19	26	4.92	+1.91	Ironwood	10.74	Manistee	2.07
Minnesota	55.0	−3.5	2 stations	92	1	3 stations	20	25	5.33	+2.56	Saint Cloud	10.72	Crookston	0.65
Mississippi	80.1	+4.1	do	102	[2] 8	2 stations	51	26	1.50	−1.70	Poplarville	5.78	Pontotoc	T.
Missouri	69.3	+0.3	Marshall	97	8	Unionville	27	26	8.79	+5.06	Maryville	18.04	Sikeston	2.23
Montana	48.3	−6.7	2 stations	93	1	Pleasant Valley	−7	24	2.44	+1.18	Adel	9.14	Knowlton	0.28
Nebraska	61.8	−2.1	Curtis	101	1	Gordon	1	25	3.51	+1.38	Syracuse	13.93	Scottsbluff	0.63
Nevada	60.0	−2.9	Logandale	105	10	Rye Patch	10	25	0.07	−0.36	Arthur	0.82	26 stations	0.00
New England	58.4	−1.7	5 stations	89	[2] 1	Garfield, Vt	25	28	2.38	−1.29	Pittsburg (b), N. H.	4.75	Provincetown, Mass	0.80
New Jersey	64.5	−0.9	2 stations	93	25	Charlotteburg	32	27	4.18	+0.52	New Brunswick	7.09	Atlantic City	1.53
New Mexico	65.9	+1.9	Nara Visa (near)	105	[2] 2	Senorito (near)	23	6	2.27	+0.74	Pastura	6.93	Roy	0.30
New York	60.2	−0.9	2 stations	91	[2] 22	2 stations	27	[2] 14	4.10	+0.65	Norwich	7.33	Setauket	1.57
North Carolina	74.2	+3.9	do	100	[2] 3	do	46	21	1.69	−2.28	Mount Mitchell	6.66	Stonewall	0.00
North Dakota	52.3	−4.1	do	95	[2] 1	Crosby	9	25	2.42	+0.78	Pembina	5.00	Hettinger	0.39
Ohio	66.6	+1.0	do	93	[2] 4	Van Wert	29	26	7.28	+4.40	Sidney	13.86	Dam No. 28	1.68
Oklahoma	74.1	+0.1	Hooker	105	1	Hooker	33	26	6.75	+3.67	Pensacola	14.07	Kenton	0.99
Oregon	55.6	−3.1	McMinnville	99	4	Harney Branch Experiment Station.	2	24	0.97	−0.33	Welches	7.45	6 stations	0.00
Pennsylvania	64.2	+0.2	Gettysburg	99	25	West Bingham	26	14	5.81	+2.33	Vandergrift	13.90	Lawrenceville	2.23
South Carolina	77.0	+2.6	Garnette	101	3	Caesar's Head	52	[2] 27	2.29	−1.67	Caesar's Head	6.52	Heath Springs	0.18
South Dakota	58.3	−2.7	6 stations	100	[2] 1	Elm Springs	6	25	2.29	+0.66	Vermillion	7.03	Eales	0.32
Tennessee	76.1	+4.7	2 stations	98	[2] 3	Clarksville	45	26	2.19	−0.87	Jackson (No. 2)	4.80	Covington	0.33
Texas	79.6	+2.4	Fort McIntosh	110	21	Vega	31	26	2.14	−0.74	Colorado	8.96	2 stations	0.00
Utah	58.8	−0.9	Saint George	99	[2] 10	Woodruff	2	25	0.95	−0.14	Trout Creek Ranger Station.	2.66	do	0.00
Virginia	70.5	+1.8	Winchester	96	[2] 1	Staunton	37	27	2.64	−0.51	Culpeper	8.97	Chatham	0.51
Washington	54.8	−3.8	Wahluke	94	4	4 stations	12	[2] 23	2.08	+0.30	Paradise Inn	7.78	Naches Heights	0.01
West Virginia	68.6	+3.0	Point Pleasant	98	[2] 6	Terra Alta	31	11	5.35	+2.41	New Cumberland	10.57	Bluefield	1.44
Wisconsin	57.2	−2.3	2 stations	90	[2] 2	2 stations	19	[2] 26	5.88	+2.30	Richland Center	9.38	Marinette	2.97
Wyoming	50.4	−4.2	Wheatland	94	20	Riverside	−9	24	1.33	+0.10	Buffalo	3.75	Nine Mile Creek	0.01
Alaska (August)	55.8	+2.2	2 stations	89	[2] 14	4 stations	28	[2] 4	3.48	−2.09	Cordova	12.70	McKinley Park	0.46
Porto Rico	79.3	+0.4	Arecibo	98	5	Aibonito	56	[2] 9	6.72	−1.27	Utuado	18.32	Potala	1.34

[1] For description of tables and charts, see REVIEW, January 1926, p. 32.
[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, September, 1926*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	° F.	° F.	° F.		° F.	° F.		° F.	° F.	° F.	° F.	%	In.	In.		Miles.								0-10	In.	In.
New England							59.7	−1.2										81	1.87	−1.3										5.6		
Eastport	76	67	85	30.04	30.12	+0.09	54.6	−1.2	72	7	62	40	30	47	23	52	50	87	2.23	−0.7	9	6,170	s.	30	e.	17	5	14	11	6.4	0.0	0.0
Greenville, Me	1,070	6	......	28.97	30.14	......	53.2	......	78	19	64	30	29	43	38	......	......	......	3.47	......	15	3,635	se.	27	n.	26	8	8	14	......	0.0	0.0
Portland, Me	103	82	117	30.04	30.16	+.11	58.5	−1.1	78	25	66	42	27	51	30	53	50	75	1.80	−1.3	9	5,351	s.	32	n.	13	16	4	10	4.6	0.0	0.0
Concord	289	70	79	29.84	30.15	+.09	58.2	−1.1	85	25	70	35	27	46	38	......	......	......	1.84	−1.4	6	2,794	se.	20	nw.	13	8	12	10	5.7	0.0	0.0
Burlington	403	11	48	29.69	30.13	+.07	57.8	−2.5	79	24	66	37	27	49	27	......	......	......	2.35	−1.0	10	6,431	s.	34	s.	24	8	8	14	6.5	0.0	0.0
Northfield	876	12	60	29.21	30.16	+.10	54.5	−1.6	80	25	66	32	14	43	35	51	50	91	2.43	−0.3	13	4,349	s.	22	sw.	6	5	11	14	6.9	0.0	0.0
Boston	125	115	188	30.00	30.14	+.07	62.4	−0.8	89	25	70	47	27	55	25	57	53	73	1.08	−2.1	9	5,501	e.	21	s.	9	11	11	8	5.0	0.0	0.0
Nantucket	12	14	90	30.12	30.13	+.05	61.1	−1.7	74	20	67	48	27	55	21	57	55	84	0.83	−1.9	8	10,958	ne.	43	n.	17	10	3	17	6.1	T.	0.0
Block Island	26	11	46	30.10	30.13	+.05	62.6	−0.8	76	7	67	52	26	58	18	59	56	83	1.21	−1.8	6	10,807	e.	38	ne.	17	11	7	12	5.1	0.0	0.0
Providence	160	215	251	29.97	30.14	+.07	61.9	−1.3	86	25	71	42	27	53	28	56	53	75	1.58	−1.6	11	6,043	n.	36	nw.	26	10	12	8	5.0	0.0	0.0
Hartford	159	122	140	29.97	30.14	+.07	61.8	+0.1	87	25	71	43	27	53	31	......	......	......	2.45	−1.0	11	......	s.	......	......	......	15	6	9	4.6	0.0	0.0
New Haven	106	74	153	30.02	30.14	+.07	62.8	−0.7	85	25	71	45	27	55	26	58	55	78	2.73	−1.1	9	5,820	ne.	24	n.	26	11	9	10	5.4	0.0	0.0
Middle Atlantic States							67.2	+0.4										81	3.19	−0.2										5.9		
Albany	97	102	115	30.03	30.13	+.06	61.6	−1.5	86	25	71	42	27	52	35	57	55	82	1.89	−1.3	11	4,500	s.	28	s.	9	13	6	11	5.1	0.0	0.0
Binghamton	871	10	84	29.20	30.14	+.07	61.2	−0.1	83	24	71	38	14	51	38	......	......	......	1.92	−0.8	11	3,385	e.	36	sw.	9	8	4	18	6.7	0.0	0.0
New York	314	414	454	29.80	30.13	+.05	64.8	−2.0	86	25	71	51	26	58	24	59	56	76	5.51	+1.9	8	8,884	e.	52	nw.	25	9	10	11	5.9	0.0	0.0
Harrisburg	374	94	104	29.73	30.13	+.05	64.8	−1.0	87	25	72	45	27	57	31	61	58	83	5.12	+2.3	10	3,808	ne.	42	w.	6	6	8	16	6.7	0.0	0.0
Philadelphia	114	123	190	30.01	30.14	+.06	67.6	−0.4	89	25	74	51	27	61	24	62	59	79	4.88	+1.5	10	5,380	ne.	34	n.	26	8	10	12	5.9	0.0	0.0
Reading	325	81	98	29.78	30.12	......	65.2	......	90	25	73	46	27	57	31	60	58	83	4.07	+0.4	11	3,748	e.	23	nw.	25	9	8	13	5.9	0.0	0.0
Scranton	805	111	119	29.28	30.14	+.07	62.0	−0.9	81	25	71	41	1	53	36	57	54	80	3.80	+0.9	10	3,758	n.	22	nw.	25	6	7	17	7.0	0.0	0.0
Atlantic City	52	37	172	30.06	30.12	+.05	67.2	+0.4	81	13	72	51	26	62	22	63	60	81	1.53	−1.5	7	12,349	ne.	42	ne.	3	9	12	9	4.9	0.0	0.0
Cape May	17	13	49	30.09	30.11	+.04	67.7	−1.3	86	2	75	50	27	61	25	65	63	87	1.54	−1.5	6	......	e.	......	......	......	......	......	......	......	0.0	0.0
Sandy Hook	22	10	55	30.10	30.12	......	65.8	......	86	25	71	53	27	61	20	60	57	78	3.00	......	11	9,774	ne.	45	n.	26	13	5	12	5.1	0.0	0.0
Trenton	190	159	183	29.93	30.13	......	65.1	......	89	25	73	47	27	57	26	60	57	79	4.57	+1.0	11	6,769	sw.	31	n.	26	9	8	13	5.8	0.0	0.0
Baltimore	123	100	215	29.98	30.11	+.03	69.6	+1.1	92	25	77	51	27	62	27	63	60	78	4.19	+0.3	13	6,282	s.	39	nw.	9	10	7	13	6.0	0.0	0.0
Washington	112	62	85	29.99	30.11	+.03	69.0	+0.9	91	25	77	50	27	61	29	63	61	82	6.80	+3.2	12	3,601	n.	36	nw.	25	4	13	13	6.3	0.0	0.0
Cape Henry	18	8	54	30.07	30.09	......	72.7	......	96	2	78	59	13	67	26	67	65	80	1.74	−2.3	5	9,006	ne.	50	n.	26	14	4	12	5.2	0.0	0.0
Lynchburg	681	153	188	29.38	30.12	+.04	71.8	+2.8	93	24	81	52	27	63	34	64	62	80	1.50	−2.0	10	3,811	e.	25	nw.	6	5	13	12	6.4	0.0	0.0
Norfolk	91	170	205	30.01	30.11	+.05	73.2	+1.6	91	2	80	59	26	66	25	66	64	79	2.17	−1.9	7	7,598	ne.	38	n.	26	11	6	13	5.7	0.0	0.0
Richmond	144	11	52	29.97	30.12	+.05	71.2	+0.7	91	25	80	54	12	63	28	65	63	84	1.46	−2.0	11	4,714	ne.	32	ne.	26	9	11	10	5.5	0.0	0.0
Wytheville	2,304	49	55	27.77	30.00	+.02	69.2	+5.6	85	9	78	52	27	60	28	64	62	88	1.37	−1.9	11	2,827	w.	19	nw.	9	4	13	13	6.4	0.0	0.0
South Atlantic States							76.9	+3.6										81	2.51	−2.1										5.0		
Asheville	2,253	70	84	27.80	30.10	+.03	71.5	+0.5	86	3	80	54	27	63	24	65	64	87	0.94	−2.0	10	4,202	se.	21	se.	11	2	21	7	6.3	0.0	0.0
Charlotte	779	55	62	29.27	30.09	+.02	76.3	+4.8	94	2	86	54	27	67	26	68	65	75	0.05	−3.2	2	2,366	ne.	13	ne.	26	10	12	8	5.2	0.0	0.0
Hatteras	11	11	50	30.06	30.07	+.01	74.9	+0.4	86	2	80	60	20	70	19	71	69	82	0.80	−4.5	3	8,894	ne.	40	n.	15	16	8	6	3.8	0.0	0.0
Raleigh	376	103	110	29.70	30.09	+.02	74.2	+3.1	92	2	83	57	27	65	30	67	64	78	1.32	−2.0	4	4,531	ne.	23	ne.	26	10	7	13	5.4	0.0	0.0
Wilmington	78	81	91	30.01	30.09	+.04	76.5	+3.4	97	3	85	60	27	68	27	71	69	83	1.70	−3.6	5	4,020	ne.	21	e.	3	10	13	7	4.9	0.0	0.0
Charleston	48	11	92	30.01	30.06	+.02	79.4	+2.8	95	2	85	66	27	74	19	74	72	81	2.66	−2.8	7	6,672	ne.	34	e.	18	8	14	8	5.1	0.0	0.0
Columbia, S. C	351	41	57	29.71	30.08	+.03	78.6	+4.1	98	3	88	61	27	69	25	70	67	77	1.09	−2.4	4	3,672	ne.	17	s.	6	17	5	8	4.5	0.0	0.0
Due West	711	10	55	29.34	30.11	......	77.0	......	95	3	86	59	27	68	26	......	......	......	0.60	......	4	4,371	ne.	20	e.	18	12	10	8	5.0	0.0	0.0
Greenville, S. C	1,039	139	146	29.00	30.08	......	75.8	+5.2	92	2	84	56	27	68	23	68	66	79	1.44	......	5	4,955	ne.	30	ne.	11	9	14	7	5.2	0.0	0.0
Augusta	182	62	77	29.87	30.06	+.01	80.0	+4.7	97	3	89	65	27	71	24	72	70	79	0.96	−2.8	6	2,602	e.	19	ne.	18	14	10	6	4.4	0.0	0.0
Savannah	65	150	194	29.98	30.05	+.02	79.6	+3.4	97	1	87	65	28	72	22	73	72	83	6.01	+0.4	9	6,478	ne.	36	e.	18	14	9	7	4.5	0.0	0.0
Jacksonville	43	209	245	29.97	30.02	+.02	79.2	+0.9	94	1	85	68	16	73	22	74	72	83	9.55	+1.5	17	7,750	e.	50	e.	18	8	11	11	5.8	0.0	0.0
Florida Peninsula							82.6	+1.4										80	6.59	−1.0										5.6		
Key West	22	10	64	29.89	29.91	−.03	83.0	+0.8	90	5	88	74	24	78	14	77	75	79	2.17	−4.6	14	7,220	e.	52	w.	18	14	10	6	4.9	0.0	0.0
Miami	25	71	79	29.89	29.92	......	82.8	+1.3	92	26	89	74	8	77	16	76	74	78	12.10	+3.4	16	4,119	se.	80	ne.	18	8	12	10	6.0	0.0	0.0
Tampa	35	79	87	29.93	29.96	−.01	82.1	+2.2	93	4	90	71	25	74	19	75	73	83	5.50	−1.9	17	5,388	e.	50	se.	19	4	19	7	5.7	0.0	0.0
Titusville	44	5	......	29.93	29.98	......	81.6	......	93	2	88	70	1	75	23	......	......	......	5.11	......	14	......	e.	......	......	......	5	16	9	5.9	0.0	0.0
East Gulf States							79.6	+4.0										80	4.99	+1.1										4.3		
Atlanta	1,173	190	216	28.86	30.07	+.02	77.4	+5.0	90	3	85	62	28	69	22	69	66	75	1.20	−2.3	5	6,060	e.	28	se.	21	13	6	11	5.1	0.0	0.0
Macon	370	78	87	29.66	30.05	+.02	78.6	+3.8	95	1	88	64	25	69	27	72	70	81	6.68	+3.3	9	3,318	e.	35	ne.	4	14	11	5	4.0	0.0	0.0
Thomasville	273	49	58	29.73	30.02	+.01	79.6	+2.8	94	1	89	65	16	71	23	72	70	82	9.43	+5.2	11	3,173	ne.	24	ne.	18	7	15	8	5.5	0.0	0.0
Apalachicola	36	42	49	29.94	29.98	......	80.2	......	91	1	86	71	16	75	16	75	73	83	4.61	......	5	7,806	ne.	64	ne.	19	20	6	4	3.1	0.0	0.0
Pensacola	56	149	185	29.90	29.97	−.02	80.0	+2.0	90	18	86	70	27	74	17	75	73	81	9.09	+3.9	6	9,815	ne.	116	e.	20	18	7	5	3.9	0.0	0.0
Anniston	741	9	57	29.29	30.07	+.04	78.3	+7.0	93	4	88	62	27	68	25	......	......	......	2.76	−0.8	8	2,583	s.	15	e.	20	14	15	1	3.7	0.0	0.0
Birmingham	700	11	48	29.30	30.05	+.02	79.4	+4.6	94	17	89	59	26	70	27	71	69	79	1.65	−1.8	8	3,827	s.	23	s.	14	14	11	5	4.5	0.0	0.0
Mobile	57	125	161	29.91	29.97	−.03	80.8	+2.7	94	10	88	67	27	73	20	74	72	83	10.62	+5.6	8	7,609	n.	94	n.	20	17	10	3	3.9	0.0	0.0
Montgomery	223	100	112	29.79	30.03	+.01	80.4	+4.1	94	3	89	67	27	72	21	72	70	79	4.93	+2.0	7	4,210	ne.	38	ne.	20	12	14	4	4.7	0.0	0.0
Corinth	469	6	......	......	......	......	79.3	......	96	8	90	53	26	68	34	......	......	......	1.40	......	6	......	ne.	......	......	......	5	23	2	......	0.0	0.0
Meridian	375	87	95	29.62	30.00	−.02	78.9	+4.4	93	8	88	57	26	70	29	72	69	79	1.09	−2.4	5	3,654	e.	29	ne.	21	14	11	5	4.4	0.0	0.0
Vicksburg	247	65	73	29.73	30.01	−.01	80.0	+3.7	93	17	89	56	26	71	30	71	68	74	1.47	−1.9	6	4,496	se.	26	se.	22	13	13	4	4.5	0.0	0.0
New Orleans	53	76	84	29.91	29.96	−.02	82.6	+3.4	93	9	89	70	27	76	18	75	73	79	6.01	+1.2	10	4,743	se.	27	nw.	21	10	17	3	4.7	0.0	0.0
West Gulf States							80.1	+3.2										75	2.01	−1.4										4.3		
Shreveport	249	77	93	29.71	29.98	−.02	80.7	+3.8	96	13	91	54	26	71	29	72	69	77	1.01	−2.2	4	4,229	se.	24	s.	3	15	11	4	3.9	0.0	0.0
Bentonville	1,303	11	44	......	......	......	71.3	+2.4	90	23	80	44	25	62	39	......	......	......	9.34	......	11	3,468	s.	17	s.	30	14	7	9	......	0.0	0.0
Fort Smith	457	79	94	29.50	29.97	−.04	77.0	+3.0	95	23	86	50	26	68	29	69	65	73	6.83	+3.7	6	5,185	e.	25	se.	4	12	9	9	4.9	0.0	0.0
Little Rock	357	136	144	29.62	30.00	−.03	77.4	+3.3	94	14	86	50	26	68	26	69	66	74	1.19	−2.1	7	5,228	s.	31	n.	9	14	8	8	4.5	0.0	0.0
Brownsville	57	53	61	29.82	29.88	......	83.0	+2.4	99	22	91	66	27	75	26	75	74	83	4.27	......	15	4,505	se.	20	se.	3	17	12	1	3.6	0.0	0.0
Corpus Christi	20	11	73	29.90	29.92	−.03	83.4	+3.7	100	21	89	65	26	78	24	76	74	78	0.83	−3.2	10	7,482	se.	38	n.	25	17	11	2	3.3	0.0	0.0
Dallas	512	109	117	29.42	29.96	......	80.1	......	95	21	90	51	26	70	29	......	......	......	2.64	......	5	5,403	s.	28	s.	4	16	9	5	3.9	0.0	0.0
Fort Worth	670	106	114	29.24	29.94	−.05	80.0	+3.1	99	23	90	50	26	70	32	69	65	68	1.41	−1.0	5	6,550	s.	27	s.	24	14	10	6	4.4	0.0	0.0
Galveston	54	106	114	29.90	29.96	−.02	83.2	+3.1	93	21	87	69	27	79	14	76	74	76	3.89	−1.5	6	8,230	se.	28	se.	3	13	13	4	4.2	0.0	0.0
Groesbeck	461	11	56	29.48	29.95	......	81.2	......	97	21	92	54	26	70	31	......	......	......	0.51	......	6	6,541	s.	35	s.	3	9	18	3	4.8	0.0	0.0
Houston	138	292	314	29.81	29.95	......	81.8	+2.8	94	21	89	62	27	74	22	......	......	......	2.43	......	12	8,537	se.	44	se.	23	12	15	3	4.5	0.0	0.0
Palestine	510	64	72	29.44	29.96	−.03	80.4	+3.4	94	5	90	55	26	71	23	71	69	76	1.93	−1.3	10	4,878	s.	28	s.	1	7	20	3	5.0	0.0	0.0
Port Arthur	34	58	66	29.91	29.96	......	82.8	......	95	21	89	64	26	76	23	......	......	......	1.76	......	4	5,241	se.	22	ne.	18	19	9	2	3.3	0.0	0.0
San Antonio	693	119	132	29.20	29.92	−.04	82.4	+3.4	101	22	93	55	26	72	35	72	68	69	0.43	−2.5	7	5,320	se.	29	se.	3	8	15	7	5.0	0.0	0.0
Taylor	583	55	63	29.37	29.98	+.01	81.0	+4.1	99	22	92	53	26	70	34	......	......	......	0.53	−2.5	9	5,331	se.	29	s.	3	11	16	3	4.5	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, September, 1926*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Ohio Valley and Tennessee							**71.8**	**+2.8**										**81**	**4.53**	**+1.8**										**6.0**		
Chattanooga	762	189	213	29.25	30.05	−.01	77.0	+4.8	92	4	86	60	26	68	23	70	67	77	2.53	−0.7	5	3,749	se.	31	sw.	13	7	16	7	5.2	0.0	0.0
Knoxville	995	102	111	29.02	30.06	.00	76.8	+6.2	92	3	86	57	26	68	26	69	67	80	1.84	−1.0	7	3,395	sw.	22	sw.	9	7	17	6	5.0	0.0	0.0
Memphis	399	76	97	29.50	30.01	−.02	77.8	+4.2	93	14	86	51	26	69	26	70	67	74	0.43	−2.6	4	4,948	e.	33	nw.	5	13	11	6	4.4	0.0	0.0
Nashville	546	168	191	29.49	30.06	.00	76.9	+5.1	92	14	86	52	26	67	28	69	66	76	2.52	−1.2	6	5,007	ne.	28	s.	23	12	11	7	4.9	0.0	0.0
Lexington	989	193	230	29.02	30.07	.00	71.6	+3.1	88	14	80	42	26	63	27	.....	.....	.....	4.04	+1.6	9	7,973	sw.	48	ne.	2	12	12	6	4.6	0.0	0.0
Louisville	525	188	234	29.50	30.08	+.02	71.8	+1.3	89	22	80	44	26	63	27	66	64	81	5.34	+2.7	13	6,386	n.	42	s.	5	7	13	10	5.6	0.0	0.0
Evansville	431	76	116	29.60	30.06	.00	73.7	+3.0	91	16	83	44	25	65	28	66	63	77	3.42	+0.8	10	5,238	sw.	34	sw.	22	4	18	8	6.0	0.0	0.0
Indianapolis	822	194	230	29.18	30.06	.00	67.8	+0.9	87	4	76	38	26	60	25	62	60	83	9.33	+6.3	17	6,718	s.	38	w.	15	6	11	13	6.5	0.0	0.0
Royal Center	736	11	55	29.27	30.06	.....	64.0	.....	86	19	72	35	26	56	28	.....	.....	.....	7.79	.....	18	5,787	e.	28	n.	24	6	5	19	7.3	0.0	0.0
Terre Haute	575	96	129	29.43	30.04	.....	69.2	.....	88	17	77	39	26	61	25	64	62	84	11.38	.....	18	5,676	s.	31	s.	23	4	11	15	6.7	0.0	0.0
Cincinnati	627	11	51	29.40	30.08	+.01	69.0	+1.9	88	4	78	39	26	60	33	64	62	84	4.10	+1.8	17	3,859	ne.	30	sw.	4	6	10	14	6.6	0.0	0.0
Columbus	822	179	222	29.22	30.09	+.02	67.5	+1.0	88	4	76	38	26	59	27	62	60	82	5.77	+3.2	14	5,512	s.	36	nw.	15	6	7	17	6.9	0.0	0.0
Dayton	899	137	172	29.10	30.05	.....	67.8	+1.2	88	4	77	38	26	59	29	62	60	82	6.26	+3.8	18	5,151	ne.	29	nw.	4	6	13	11	6.5	0.0	0.0
Elkins	1,947	59	67	28.09	30.11	+.03	66.4	+3.4	86	5	76	45	11	56	33	61	60	91	5.00	+2.1	18	2,398	nw.	31	w.	6	4	13	13	6.6	0.0	0.0
Parkersburg	637	77	82	29.45	30.10	+.02	70.2	+2.9	90	4	79	48	26	61	33	64	62	83	5.41	+2.7	14	2,915	n.	26	nw.	25	6	9	15	6.6	0.0	0.0
Pittsburgh	842	353	410	29.20	30.09	+.01	67.2	+0.8	87	22	76	44	26	50	30	62	59	83	7.45	+5.0	12	6,103	ne.	32	sw.	5	8	9	13	6.0	0.0	0.0
Lower Lake Region							**62.1**	**−0.9**										**80**	**5.60**	**+2.8**										**6.7**		
Buffalo	767	247	280	29.27	30.09	+.03	61.2	−1.2	80	18	69	40	26	54	27	57	54	81	4.43	+1.2	12	10,018	sw.	50	sw.	24	7	9	14	6.3	0.0	0.0
Canton	448	10	61	29.63	30.10	.....	57.3	−2.0	80	24	66	34	14	48	30	.....	.....	.....	3.85	+1.0	12	5,869	sw.	33	sw.	24	9	10	11	5.7	0.0	0.0
Oswego	335	76	91	.....	30.11	+.05	59.0	−2.2	80	24	66	40	27	52	25	.....	.....	81	3.04	+0.2	11	6,414	sw.	28	se.	5	10	7	13	.....	0.0	0.0
Rochester	523	86	102	29.55	30.12	+.06	61.1	−1.3	83	19	69	41	29	53	28	56	52	77	4.14	+1.8	12	4,873	ne.	26	w.	6	5	9	16	6.8	0.0	0.0
Syracuse	597	97	113	29.48	30.13	+.06	60.0	−1.6	82	24	68	39	14	52	33	.....	.....	.....	5.01	+2.2	14	3,740	s.	27	nw.	9	7	9	14	6.5	0.0	0.0
Erie	714	130	166	29.31	30.08	+.02	63.6	0.0	83	24	71	44	27	56	25	58	55	75	5.73	+2.2	11	9,327	n.	36	s.	23	7	11	12	5.7	0.0	0.0
Cleveland	762	190	201	29.26	30.08	+.02	65.1	+1.2	84	24	72	46	26	58	26	60	57	79	9.10	+5.9	15	7,696	s.	36	n.	12	5	8	17	7.3	0.0	0.0
Sandusky	629	62	70	29.40	30.08	+.02	65.4	+0.1	85	19	72	47	26	59	21	.....	.....	.....	7.01	+4.3	15	5,123	sw.	26	n.	25	4	6	20	7.4	0.0	0.0
Toledo	628	208	243	29.41	30.09	+.03	63.4	−1.0	84	19	71	38	26	56	24	59	57	83	8.07	+5.7	14	7,747	sw.	43	sw.	23	6	8	16	6.6	0.0	0.0
Fort Wayne	856	113	124	29.15	30.07	.....	64.2	−1.3	86	19	72	36	26	56	30	59	57	84	6.76	.....	18	5,045	e.	25	nw.	24	6	9	15	6.8	0.0	0.0
Detroit	730	218	258	29.30	30.10	+.04	62.8	−0.7	82	22	70	37	26	56	23	57	54	78	5.67	+3.2	14	6,175	sw.	32	sw.	23	5	4	21	7.5	0.0	0.0
Upper Lake Region							**57.5**	**−2.3**										**83**	**4.50**	**+1.3**										**7.0**		
Alpena	609	13	92	29.43	30.09	+.06	55.9	−1.7	77	19	63	30	26	49	27	52	50	83	2.94	−0.5	12	8,398	e.	35	se.	21	6	7	17	6.9	0.0	0.0
Escanaba	612	54	60	29.40	30.06	+.05	54.2	−2.9	76	18	61	26	26	47	28	51	48	82	3.60	0.0	16	7,139	s.	38	s.	8	6	9	15	6.6	0.0	0.0
Grand Haven	632	54	89	29.38	30.05	+.01	60.0	−0.9	81	17	68	38	26	52	33	56	53	81	4.82	+1.6	10	6,464	e.	41	w.	6	5	9	16	7.0	0.0	0.0
Grand Rapids	707	70	87	29.31	30.08	+.03	61.2	−1.5	81	1	70	36	26	52	34	56	53	80	4.80	+1.7	14	3,587	e.	25	nw.	24	4	8	18	7.3	0.0	0.0
Houghton	668	62	99	29.32	30.05	+.05	52.2	−4.7	71	8	59	35	27	46	22	.....	.....	.....	5.71	+2.2	14	8,043	e.	44	w.	24	4	9	17	7.3	T.	0.0
Lansing	878	11	62	29.14	30.08	.....	60.4	−1.0	83	19	71	20	26	50	33	57	55	90	3.71	+1.1	14	3,144	s.	20	s.	8	7	6	17	6.7	0.0	0.0
Ludington	637	60	66	29.36	30.06	.....	58.5	.....	82	1	65	38	28	52	29	54	51	81	2.44	.....	13	7,062	e.	31	s.	21	6	12	12	6.2	0.0	0.0
Marquette	734	77	111	29.26	30.07	+.07	52.8	−4.7	74	18	60	31	26	46	25	50	47	85	6.48	+3.0	13	7,173	w.	40	s.	21	3	11	16	7.2	0.0	0.0
Port Huron	638	70	120	29.39	30.08	+.02	60.6	−1.0	82	19	68	33	26	53	26	56	53	81	3.02	+0.3	12	6,785	sw.	35	nw.	19	7	10	13	6.2	0.0	0.0
Saginaw	641	.....	.....	29.39	30.08	.....	60.0	−1.8	86	1	71	30	26	49	33	.....	.....	.....	3.80	.....	11	.....	w.	.....	.....	.....	5	5	20	.....	0.0	0.0
Sault Ste. Marie	614	11	52	29.40	30.10	+.06	52.8	−2.7	71	18	60	32	26	46	26	49	47	87	3.23	−0.2	15	5,542	se.	33	nw.	24	4	9	17	7.4	0.2	0.0
Chicago	673	7	131	29.33	30.06	+.02	64.4	−0.8	87	18	71	38	26	58	26	59	57	82	5.03	+2.0	17	7,202	s.	29	s.	23	6	7	17	6.8	0.0	0.0
Green Bay	617	100	141	29.39	30.05	+.03	57.8	−2.6	84	18	65	30	26	50	32	53	50	81	4.87	+1.8	12	7,001	s.	36	s.	18	4	8	18	7.2	0.0	0.0
Milwaukee	681	125	130	29.32	30.06	+.03	61.8	−0.9	88	18	68	35	26	55	21	56	53	79	4.60	+1.8	8	7,505	ne.	34	e.	3	8	4	18	7.0	0.0	0.0
Duluth	1,133	5	47	28.82	30.04	+.06	50.7	−4.4	74	21	58	25	25	44	28	47	46	90	5.51	+2.0	16	9,293	ne.	45	ne.	3	4	8	18	7.5	T.	0.0
North Dakota							**52.2**	**−4.9**										**75**	**2.94**	**+1.5**										**5.6**		
Moorhead	940	50	58	28.95	29.97	+.01	53.8	−4.4	85	1	64	24	25	43	38	49	45	78	4.18	+1.9	11	6,283	s.	31	s.	16	9	8	13	6.1	T.	0.0
Bismarck	1,674	8	57	28.21	29.99	+.05	53.7	−4.4	87	1	66	19	25	42	43	47	42	72	2.31	+1.1	10	7,204	n.	42	nw.	23	10	8	12	5.6	T.	0.0
Devils Lake	1,478	11	44	28.39	29.97	+.03	50.5	−5.1	86	1	61	20	25	40	38	45	41	79	2.87	+1.5	13	6,836	se.	38	nw.	23	10	9	11	5.2	T.	0.0
Ellendale	1,457	10	56	28.40	29.96	.....	54.2	.....	85	16	65	21	25	44	34	.....	.....	.....	2.29	.....	10	9,639	se.	48	nw.	23	10	11	9	5.6	T.	0.0
Grand Forks	833	12	67	.....	.....	.....	52.8	.....	88	1	64	24	25	41	41	47	.....	.....	1.29	.....	10	.....	nw.	39	se.	16	7	10	13	.....	T.	0.0
Williston	1,878	41	48	27.98	29.97	+.04	51.0	−5.6	80	1	61	19	25	40	37	44	39	71	2.41	+1.5	12	5,148	se.	35	ne.	23	9	8	13	6.0	2.8	0.0
Upper Mississippi Valley							**64.2**	**−1.0**										**83**	**8.28**	**+5.0**										**6.8**		
Minneapolis	918	102	208	29.01	29.99	.....	57.4	−4.0	88	17	65	31	25	50	27	.....	.....	.....	5.18	+1.5	12	8,348	se.	45	se.	8	4	8	18	7.3	0.0	0.0
St. Paul	837	236	261	29.09	30.00	+.01	57.0	−4.3	86	17	65	31	26	49	27	.....	.....	.....	5.43	+2.0	16	8,728	se.	52	se.	8	1	10	19	7.7	0.0	0.0
La Crosse	714	11	48	29.25	30.01	.00	59.6	−2.6	86	17	67	30	26	52	27	.....	.....	.....	4.92	+0.8	13	3,156	e.	17	se.	21	6	7	17	7.2	0.0	0.0
Madison	974	70	78	29.02	30.06	+.03	60.5	−1.9	86	17	68	30	26	53	28	56	53	83	6.54	+3.4	15	5,870	se.	28	se.	30	5	7	18	7.0	0.0	0.0
Wausau	1,247	4	.....	28.72	30.06	.....	54.8	.....	82	17	63	28	26	47	32	.....	.....	.....	5.00	.....	13	.....	n.	.....	.....	.....	7	1	22	7.5	0.0	0.0
Charles City	1,015	10	49	28.95	30.02	+.02	60.4	−0.6	88	17	68	28	26	52	27	56	54	83	5.12	+2.3	11	4,926	se.	28	s.	21	8	7	15	6.4	0.0	0.0
Davenport	606	71	79	29.37	30.03	.00	64.2	−1.4	89	18	72	34	26	57	24	60	58	83	8.80	+5.7	17	4,679	e.	22	s.	8	7	6	17	6.9	0.0	0.0
Des Moines	861	84	97	29.09	29.99	−.03	64.1	−1.5	89	17	72	30	26	56	26	59	57	82	10.25	+7.2	16	5,245	s.	34	sw.	21	6	3	21	7.6	0.0	0.0
Dubuque	700	81	96	29.27	30.01	−.02	62.8	−1.2	88	17	70	31	26	56	26	58	55	82	5.48	+1.9	14	4,319	s.	22	s.	21	5	7	18	7.3	0.0	0.0
Keokuk	614	64	78	29.36	30.03	.00	66.2	−1.3	90	17	74	38	26	59	26	61	59	82	12.56	+8.6	16	4,430	s.	29	sw.	3	6	9	15	6.6	0.0	0.0
Cairo	358	87	93	29.65	30.02	−.03	74.4	+2.9	90	16	83	46	26	66	28	68	66	82	4.30	+1.8	9	5,200	s.	34	sw.	23	9	9	12	5.6	0.0	0.0
Peoria	609	11	45	29.39	30.06	+.02	65.6	+1.3	90	18	74	31	26	58	28	61	60	88	11.55	+8.4	18	3,455	s.	25	w.	3	7	10	13	6.3	0.0	0.0
Springfield, Ill	636	10	91	29.36	30.03	−.02	67.8	+0.2	90	3	75	36	26	60	28	63	61	86	15.16	+11.8	20	4,938	s.	24	w.	3	7	8	15	6.7	0.0	0.0
Hannibal	534	74	109	29.45	30.02	−.01	67.7	0.0	90	17	75	38	26	60	26	.....	.....	.....	13.17	+9.6	20	5,337	s.	30	sw.	1	8	7	15	6.5	0.0	0.0
St. Louis	568	265	303	29.42	30.02	−.02	70.9	+0.8	92	3	78	39	26	63	35	65	62	81	7.40	+4.5	18	7,879	sw.	37	sw.	23	10	6	14	5.7	0.0	0.0
Missouri Valley							**64.3**	**−1.7**										**77**	**6.30**	**+3.6**										**5.8**		
Columbia, Mo	784	11	84	29.18	30.00	−.03	68.5	+0.3	90	18	76	37	26	60	27	.....	.....	.....	10.00	+7.2	16	4,685	s.	25	nw.	15	9	9	12	5.8	0.0	0.0
Kansas City	963	161	181	28.97	29.99	−.03	68.0	−0.9	91	23	76	38	25	60	31	63	60	80	6.33	+2.6	18	6,608	s.	31	n.	23	10	8	12	5.7	0.0	0.0
St. Joseph	967	11	49	28.96	29.98	.....	67.4	.....	90	21	76	36	25	59	31	62	59	82	8.67	.....	18	5,524	se.	34	nw.	14	9	11	10	5.4	0.0	0.0
Springfield, Mo	1,324	98	104	28.61	30.00	−.03	70.0	+1.1	90	19	78	40	25	62	30	65	63	83	8.33	+4.6	13	6,814	s.	23	sw.	8	18	3	9	4.1	0.0	0.0
Iola	984	11	50	28.94	29.97	−.04	69.4	−0.4	91	20	78	39	25	61	26	.....	.....	.....	14.21	+10.4	15	4,397	s.	24	nw.	12	9	8	13	6.1	0.0	0.0
Topeka	987	92	107	.....	.....	.....	68.1	−0.6	93	2	77	38	25	59	31	.....	.....	.....	6.40	+2.8	14	6,669	se.	32	n.	23	11	8	11	5.5	0.0	0.0
Lincoln	1,189	11	84	28.71	29.96	−.03	64.6	−1.8	90	16	74	32	25	56	36	59	56	78	6.06	+3.4	15	7,623	s.	43	nw.	23	5	6	19	7.2	0.0	0.0
Omaha	1,105	115	122	28.81	29.98	−.02	64.0	−2.8	89	16	72	33	25	56	35	58	55	78	8.85	+5.8	14	5,236	s.	30	se.	2	8	8	14	6.3	0.0	0.0
Valentine	2,598	47	54	27.26	29.96	.00	58.8	−3.7	94	16	71	12	25	47	46	51	46	69	0.77	−1.0	8	6,886	s.	42	w.	30	9	10	11	5.1	0.0	0.0
Sioux City	1,135	94	164	28.78	29.98	.00	61.6	−1.8	88	17	70	29	25	53	29	57	54	78	7.41	+4.9	16	8,837	s.	43	nw.	17	6	10	14	6.5	0.0	0.0
Huron	1,306	59	74	28.50	29.99	+.03	58.4	−2.9	92	1	70	20	25	47	38	52	48	75	1.87	+0.2	9	7,031	s.	36	nw.	23	10	9	11	5.7	0.0	0.0
Pierre	1,572	70	75	.....	29.95	.00	59.6	−4.2	100	16	72	19	25	47	44	.....	.....	66	0.74	−0.4	6	7,051	e.	42	nw.	23	15	4	11	.....	T.	0.0
Yankton	1,233	49	57	28.65	29.96	−.02	61.0	−3.0	87	16	70	26	25	52	30	.....	.....	.....	4.60	+2.2	11	5,744	s.	31	s.	17	5	10	15	6.4	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, September, 1926*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation: Thermometer above ground	Elevation: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Days with 0.01, or more	Wind: Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Northern Slope							51.4	−6.0										66	1.41	+0.3										5.1		
Billings	3,140	5					52.2		84	15	67	18	24	37	56				2.30		10		nw.				11	0	19		3.0	0.0
Havre	2,505	11	44	27.37	30.02	+.08	47.4	−9.0	76	5	58	18	24	37	38	42	37	71	2.57	+1.5	13	4,427	e.	25	sw.	25	7	8	15	6.7	1.0	0.0
Helena	4,110	87	112	25.80	30.01	+.04	46.4	−10.2	76	5	56	6	24	36	33	40	34	68	2.72	+1.7	18	4,912	sw.	27	sw.	1	7	5	18	6.6	5.9	0.0
Kalispell	2,973	48	56	26.92	29.98	+.02	46.3	−7.2	72	5	56	7	24	36	31	41	36	72	2.14	+0.8	12	3,925	nw.	28	ne.	7	8	11	11	5.6	4.3	0.0
Miles City	2,371	48	55	27.46	30.02	+.07	54.2	−7.0	85	6	66	17	25	42	44	45	37	60	0.72	−0.2	7	4,500	n.	30	n.	10	11	11	8	4.8	T.	0.0
Rapid City	3,259	50	58	26.59	29.98	+.02	56.8	−3.6	90	16	70	15	25	43	41	46	39	60	0.90	−0.4	7	5,887	n.	32	n.	23	17	6	7	3.8	T.	0.0
Cheyenne	6,088	84	101	24.01	29.92	−.04	54.2	−2.8	84	1	68	19	25	41	38	43	34	55	0.37	−0.6	6	7,158	s.	50	s.	30	15	8	7	4.3	T.	0.0
Lander	5,372	60	68	24.62	29.93	−.03	52.0	−3.7	80	10	67	10	25	37	42	42	33	58	0.54	−0.5	6	3,956	sw.	46	sw.	29	15	10	5	4.1	T.	0.0
Sheridan	3,790	10	47	26.09	29.90		50.4		83	10	64	10	25	36	52	42	37	71	2.95		9	2,976	nw.	34	nw.	10	13	9	8	5.0	1.3	0.0
Yellowstone Park	6,241	11	48	23.86	29.97	.00	44.0	−9.4	70	10	57	7	24	31	39	37	32	68	1.53	+0.5	11	6,169	s.	37	s.	22	9	11	10	5.2	6.6	2.5
North Plate	2,821	11	51	27.07	29.97	.00	61.4	−0.7	93	1	73	23	25	50	39	54	49	74	1.21	−0.3	11	5,202	s.	30	nw.	30	12	6	12	5.3	0.0	0.0
Middle Slope							67.4	−0.7										67	4.03	+2.1										4.6		
Denver	5,292	106	113	24.72	29.90	−.06	61.6	−1.8	89	1	74	25	25	49	40	48	30	52	1.48	+0.6	4	5,177	s.	38	w.	30	16	10	4	3.6	T.	0.0
Pueblo	4,685	80	86	25.26	29.87	−.09	65.2	+0.6	93	20	80	29	25	51	43	50	39	48	0.36	−0.3	4	4,281	e.	48	w.	30	15	10	5	4.0	0.0	0.0
Concordia	1,392	50	58	28.50	29.95	−.04	67.0	−1.3	97	2	76	33	25	58	36	60	56	75	4.68	+2.1	13	6,599	s.	29	s.	30	6	14	10	6.0	0.0	0.0
Dodge City	2,509	11	51	27.38	29.95	−.03	68.4	−1.0	102	1	80	36	25	57	41	59	54	70	3.08	+1.3	7	8,159	se.	46	w.	14	13	10	7	4.3	0.0	0.0
Wichita	1,358	139	158	28.53	29.94	−.06	69.4	−1.2	96	23	78	39	25	61	36	63	60	77	5.01	+1.9	11	10,034	s.	40	s.	23	11	8	11	5.6	0.0	0.0
Broken Arrow	765	11	56	29.17	29.99		72.8		96	23	82	42	25	63	43				7.27		11	8,732	s.	34	n.	24	12	8	10	4.8	0.0	0.0
Oklahoma City	1,214	10	47	28.70	29.95	−.04	72.9	+0.1	97	23	82	42	26	64	29	66	63	80	9.56	+6.8	10	7,357	s.	30	w.	3	16	7	7	4.1	0.0	0.0
Southern Slope							75.6	+2.1										68	2.62	+0.2										4.4		
Abilene	1,738	10	52	28.15	29.92	−.04	78.0	+2.7	99	22	89	42	26	67	34	65	60	66	0.45	−2.7	7	6,897	s.	30	s.	30	14	4	12	4.9	0.0	0.0
Amarillo	3,676	10	49	26.27	29.94	−.02	69.4	+0.1	96	23	81	32	25	58	35	60	56	74	5.72	+3.4	11	7,807	s.	30	ne.	24	13	10	7	4.6	0.0	0.0
Del Rio	944	64	71	28.91	29.88	−.06	83.2	+4.0	101	22	93	50	26	74	36				0.47	−2.0	2	8,038	se.	30	n.	25	14	12	4	4.2	0.0	0.0
Roswell	3,566	75	85	26.33	29.88	−.04	71.8	+1.5	95	22	84	39	26	60	39	60	54	65	3.85	+2.0	7	5,014	s.	31	ne.	25	14	10	6	4.1	0.0	0.0
Southern Plateau							72.8	+2.0										56	1.82	+0.9										2.3		
El Paso	3,778	152	175	26.14	29.82	+.06	77.4	+3.5	96	24	88	47	26	66	32	62	53	51	2.24	+0.8	7	5,804	e.	39	ne.	25	17	10	3	4.0	0.0	0.0
Sante Fe	7,013	38	53	23.29	29.83	−.10	63.2	+2.3	82	1	74	38	25	52	30	52	46	62	1.49	−0.2	7	3,869	se.	20	n.	11	15	9	6	4.1	0.0	0.0
Flagstaff	6,907	10	59	23.39	29.83	−.06	58.2	+2.7	82	9	74	33	18	43	44	47		59	1.26		7	6,571	nw.	29	sw.	20	16	13	1		0.0	0.0
Pheonix	1,108	10	82	28.63	29.75	−.06	83.4	+0.7	104	20	97	57	19	70	44	67	59	52	3.52	+2.5	6	3,071	e.	26	s.	25	20	8	2	2.2	0.0	0.0
Yuma	141	9	54	29.58	29.72	−.06	85.6	+1.9	106	10	100	60	17	71	36	70	62	54	1.85	+1.7	1	2,961	sw.	35	nw.	7	28	2	0	0.7	0.0	0.0
Independence	3,957	5	25	25.85	29.81	−.05	69.0	+1.0	96	10	88	41	30	50	44	47			0.00	−0.1	0		nw.				29	1	0	0.6	0.0	0.0
Middle Plateau							60.4	−1.5										34	0.34	−0.4										2.2		
Reno	4,532	74	81	25.41	29.86	−.09	58.2	−1.5	88	9	76	30	26	40	51	42	26	34	T.	−0.3	0	5,094	w.	36	w.	29	25	5	0	1.4	0.0	0.0
Tonopah	6,090	12	20	24.02	29.82		62.0		82	10	73	33	30	50	34	43	21	22	0.00		0		nw.								0.0	0.0
Winnemucca	4,344	18	56	25.58	29.94	+.01	55.5	−3.7	89	9	75	21	27	36	57	41	26	39	0.00	−0.3	0	4,973	sw.	33	s.	29	25	5	0	2.2	0.0	0.0
Modena	5,479	10	43	24.57	29.83	−.09	59.4	−0.6	84	11	78	26	25	41	47	42	24	32	0.06	−1.1	1	9,186	sw.	60	sw.	29	24	6	0	1.3	0.0	0.0
Salt Lake City	4,360	163	203	25.55	29.86	−.09	62.1	−2.3	86	10	74	33	25	50	34	47	33	36	0.97	+0.1	2	6,306	nw.	42	se.	20	16	9	5	3.4	0.0	0.0
Grand Junction	4,602	60	68	25.32	29.84	−.11	66.6	+0.4	91	20	81	40	24	52	40	49	34	38	0.67	−0.3	4	4,624	se.	34	se.	3	19	9	2	2.9	0 0	0.0
Northern Plateau							55.9	−4.7										50	0.93	+0.2										3.9		
Baker	3,471	48	53		30.02	+.03	51.4	−4.6	81	5	65	16	24	38	43			58	0.10	−0.7	5	3,977	se.	21	n.	23	11	13	6		0.0	0.0
Boise	2,739	78	86	27.11	29.95	−.02	57.1	−4.8	87	5	71	23	24	44	40	45	32	43	0.10	−0.3	2	3,503	nw.	26	nw.	22	22	4	4	2.7	0.0	0.0
Lewiston	757	40	48	29.16	29.96	−.02	59.0	−3.8	89	5	72	27	24	46	38				1.50	+0.8	9	1,879	e.	23	n.	23	13	8	9	5.1	T.	0.0
Pocatello	4,477	60	68	25.42	29.90	−.06	55.7	−4.5	89	9	70	18	25	41	43	42	26	38	2.72	+1.8	4	5,742	s.	33	sw.	30	21	4	5	2.7	0.0	0.0
Spokane	1,929	101	110	27.94	29.98	.00	53.2	−6.0	81	5	64	22	24	42	32	46	38	60	0.60	−0.2	10	3,751	ne.	28	n.	10	8	16	6	5.0	1.4	0.0
Walla Walla	991	57	64	28.91	29.98	−.02	50.2	−4.6	86	4	70	26	24	48	33	49	39	53	0.56	−0.4	9	3,232	s.	26	w.	15	15	10	5	3.9	0.0	0.0
North Pacific Coast Region							58.2	0.0										72	1.59	−0.8										4.8		
North Head	211	11	56	29.78	30.00	−.03	58.0	+1.5	78	8	63	42	24	53	23	54	50	81	2.23	+0.4	12	8,262	n.	48	s.	28	9	7	14	5.8	0.0	0.0
Port Angeles	29	8	53	29.99	30.02		53.2		76	3	63	30	24	44	29				1.19	−0.6	8	3,635	sw.	30	w.	21	16	7	7	4.1	0.0	0.0
Seattle	125	215	250	29.85	29.98	−.03	58.0	−0.1	79	4	65	41	26	50	25	52	46	68	0.60	−1.1	8	6,003	s.	37	s.	21	13	9	8	4.3	0.0	0.0
Tacoma	194	172	201	29.80	30.00	−.02	57.7	+0.4	78	12	66	39	25	49	26				2.16	+0.1	9	5,443	n.	28	sw.	28	8	12	10	5.5	0.0	0.0
Tatoosh Island	86	9	53	29.89	29.98	−.03	54.6	+1.6	70	3	59	44	23	51	16	51	48	83	2.10	−4.0	8	8,687	s.	42	e.	24	15	3	12	4.6	0.0	0.0
Yakima	1,071	5					56.4		89	4	73	20	24	40	49				0.26		5		nw.				10	14	6	4.7	0.0	0.0
Medford	1,425	4					60.0		94	4	78	29	26	42	54	51	46	70	0.16		1		nw.				21	5	4		0.0	0.0
Portland, Oreg	153	68	106	29.83	29.99	−.04	61.6	−0.1	90	4	71	43	23	52	33	54	48	66	2.14	+0.3	10	4,512	nw.	28	e.	24	11	10	9	4.8	0.0	0.0
Roseburg	510	9	57	29.44	29.99	−.03	59.4	−3.5	94	4	74	29	25	45	47	51	44	63	0.68	−0.4	6	2,257	nw.	17	w.	16	11	10	9	4.5	0.0	0.0
Middle Pacific Coast Region							61.8	−1.5										64	0.09	−0.5										2.7		
Eureka	62	73	89	29.93	30.00	−.01	55.4	−0.5	65	24	61	44	24	50	21	53	51	86	0.43	−0.7	4	3,672	nw.	23	n.	2	10	13	7	4.7	0.0	0.0
Point Reyes	490	7	18	29.36	29.87		54.5	−1.6	71	24	59	46	27	50	23				0.01		1	14,999	nw.	54	nw.	28	12	7	11	5.1	0.0	0.0
Red Bluff	332	50	56	29.50	29.85	−.08	69.8	−3.3	99	2	84	44	19	55	40	55	42	42	0.01	−0.8	1	3,719	se.	30	n.	28	28	2	0	0.9	0.0	0.0
Sacramento	69	106	117	29.78	29.86	−.03	67.5	−1.8	97	2	82	47	26	53	42	55	45	52	T.	−0.4	0	5,714	s.	24	s.	15	29	1	0	0.6	0.0	0.0
San Francisco	155	208	243	29.74	29.91	−.03	61.2	+0.3	88	24	69	48	27	54	33	55	51	77	T.	−0.3	0	6,500	w.	38	w.	29	18	11	1	3.0	0.0	0.0
San Jose	141	12	110	29.76	29.92		62.6	−2.1	93	1	77	41	19	48	45				0.00	−0.4	0	4,214	nw.	21	nw.	15	25	5	0	1.7	0.0	0.0
South Pacific Coast Region							66.9	−1.6										65	0.00	−0.2										1.8		
Fresno	327	89	98	29.50	29.84	−.03	71.6	−1.8	98	9	88	48	30	56	39	55	41	40	0.00	−0.3	0	5,182	nw.	27	nw.	29	30	0	0	0.2	0.0	0.0
Los Angeles	338	159	191	29.50	29.86	−.02	68.0	−1.0	83	10	77	53	27	59	25	59	55	70	0.00	−0.1	0	3,325	sw.	15	sw.	9	20	10	0	2.3	0.0	0.0
San Diego	87	62	70	29.77	29.86	−.02	66.0	−0.1	75	21	71	56	22	61	17	61	58	79	0.00	−0.1	0	4,225	nw.	20	nw.	7	18	12	0	2.9	0.0	0.0
San Luis Obispo	201	32	40	29.70	29.92	−.01	62.0	−2.5	91	23	75	43	20	50	43	53	49	72	0.00	−0.4	0	2,926	nw.	19	w.	29	24	6	0	2.0	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.81	29.89		80.9	+0.4	90	11	86	74	28	76	15				5.19	−1.6	14	6,261	e.	42	nw.	15	3	24	3	5.4	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.71	29.83	−.01	79.8	0.0	91	1	86	71	7	74	17	76	75	87	8.41	+0.5	18	4,300	nw.	34	s.	7	0	12	18	7.7	0.0	0.0
Colon	38	7	97	29.79	29.83	−.02	81.6	+1.2	94	14	88	73	4	75	20	76	75	86	10.45	−1.9	20	4,125	se.	28	ne.	18	2	12	16	7.4	0.0	0.0
Alaska																																
Juneau	80	11	54	[1] 29.98	[1] 30.07		50.6		70	6	59	32	22	42	27	46	41	74	3.28		9	2,902	s.	24	e.	14	13	6	11	5.0	0.0	0.0
Hawaiian Islands																																
Honolulu	38	86	100	[1] 29.94	[1] 29.98		79.0		86	18	84	72	23	74	13	71	67	69	0.70	−0.6	13	6,354	e.	26	ne.	24	11	17	2	4.3	0.0	0.0

[1] Pressure not corrected to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, September, 1926*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
St. Johns, N. F.	125	29.82	29.96	−0.01	53.0	−1.0	61.6	44.4	76	32	4.81	+1.10	0.0
Sydney, C. B. I.	48	30.05	30.10	+.09	56.1	−0.4	64.6	47.7	75	32	1.40	−1.88	0.0
Halifax, N. S.	88	29.89	29.99	−.05	56.9	−0.7	64.5	49.3	74	37	1.74	−1.97	0.0
Yarmouth, N. S.	65	30.01	30.08	+.03	54.6	−1.5	63.6	45.7	75	36	3.43	−0.02	0.0
Charlottetown, P. E. I.	38	30.04	30.08	+.07	56.5	−0.8	63.4	49.6	72	40	1.53	−1.87	0.0
Chatham, N. B.	28	30.00	30.03	+.03	53.8	−1.6	64.8	42.9	77	29	3.29	+0.58	0.0
Father Point, Que.	20	30.05	30.07	+.09	50.6	+0.2	57.5	43.7	69	30	2.42	−0.71	0.0
Quebec, Que.	296	29.80	30.13	+.12	54.5	−0.6	61.3	47.8	72	36	5.69	+2.02	0.0
Montreal, Que.	187	29.90	30.10	+.06	57.0	−1.4	63.9	50.2	76	38	3.55	+0.25	0.0
Stonecliffe, Ont.	489												
Ottawa, Ont.	236	29.85	30.11	+.07	57.3	−0.1	66.8	47.8	84	34	3.03	+0.34	0.0
Kingston, Ont.	285	29.75	30.06	+.02	58.2	−1.8	64.7	51.7	73	37	5.00	+2.20	0.0
Toronto, Ont.	379	29.69	30.09	+.03	59.0	0.0	66.8	51.2	80	36	5.72	+2.47	0.0
Cochrane, Ont.	930				48.0		57.0	39.0	67	25	2.43		0.0
White River, Ont.	1,244	28.72	30.04	+.06	46.2	−4.1	56.4	36.0	69	20	3.69	+0.92	0.0
Port Stanley, Ont.	592												
Southampton, Ont.	656	29.38	30.09	+.04	56.1	−1.4	64.2	47.9	76	35	3.31	+0.37	0.0
Parry Sound, Ont.	688	29.40	30.08	+.05	55.2	−0.8	63.2	47.2	77	31	1.96	−1.71	0.0
Port Arthur, Ont.	644	29.34	30.05	+.07	49.7	−2.5	56.3	43.1	65	29	5.96	+2.48	0.0
Winnipeg, Man.	760	29.16	30.00	+.06	51.4	−1.1	60.1	42.8	79	26	3.76	+1.73	1.0
Minnedosa, Man.	1,690	28.17	30.00	+.06	46.3	−4.2	55.0	37.7	76	15	3.46	+2.10	2.2
Le Pas, Man.	860				43.9		53.8	34.0	71	20	0.82		1.0
Qu'Appelle, Sask.	2,115	27.71	29.96	+.04	45.6	−5.5	56.4	34.9	77	11	1.77	+0.44	6.0
Medicine Hat, Alb.	2,144	27.67	29.94	+.02	47.6	−7.4	56.8	38.5	74	18	1.50	+0.32	3.2
Moose Jaw, Sask.	1,759				47.5		59.8	35.3	79	17	1.19		1.3
Swift Current, Sask.	2,392	27.42	29.96	+.04	45.0	−8.1	56.7	33.4	75	8	1.09	−0.13	5.1
Calgary, Alb.	3,428	26.45	30.05	+.13	42.8	−7.0	53.1	32.5	79	8	9.17	+7.81	13.5
Banff, Alb.	4,521	25.42	30.03	+.10	39.2	−6.6	49.1	29.4	72	2	3.67	+2.00	13.2
Edmonton, Alb.	2,150	27.70	30.01	+.11	41.7	−7.6	50.5	33.0	74	18	2.79	+1.46	11.2
Prince Albert, Sask.	1,450	28.45	30.04	+.14	44.7	−3.7	53.9	35.4	71	22	2.22	+0.94	0.8
Battleford, Sask.	1,592	28.27	30.03	+.13	45.3	−6.5	55.3	35.3	72	20	1.01	−0.24	1.3
Kamloops, B. C.	1,262	28.72	30.01	+.04	52.1	−5.3	64.2	40.0	85	24	0.78	−0.07	0.5
Victoria, B. C.	230	29.74	29.90	−.02	56.4	+1.6	64.4	48.5	77	40	0.91	−1.25	0.0
Barkerville, B. C.	4,180	25.70	30.03	+.05	39.4	−7.3	49.4	29.4	65	8	1.46	−1.45	4.4
Triangle Island, B. C.	680												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	29.91	30.07	0.00	78.0	+0.6	84.1	72.0	88	69	4.58	−1.93	0.0

LATE REPORT FOR JULY, 1926

Winnipeg, Man.	760	29.11	29.92	−0.01	67.9	+1.9	80.2	55.8	98	37	2.01	−1.07	0.0

LATE REPORTS FOR AUGUST, 1926

Saint Johns, N. F.	125	29.73	29.86	−.10	57.0	−2.8	64.6	49.4	78	42	3.00	−1.08	0.0
Winnipeg, Man.	760	29.15	29.98	+.04	64.3	+0.9	75.1	53.5	92	43	3.23	+0.59	0.0
Calgary, Alb.	3,428	26.46	30.00	+.09	56.5	−2.9	69.7	43.4	88	36	3.22	+1.08	0.0
Banff, Alb.	4,521	25.44	29.96	+.05	54.5	−1.8	69.5	39.5	85	29	2.90	+0.46	0.0
Kamloops, B. C.	1,262	28.67	29.93	+.02	66.5	−2.1	79.1	53.9	88	43	1.79	+0.70	0.0
Barkerville, B. C.	4,180	25.71	29.99	+.09	52.4	−3.9	63.5	41.4	71	33	2.63	−0.47	0.0

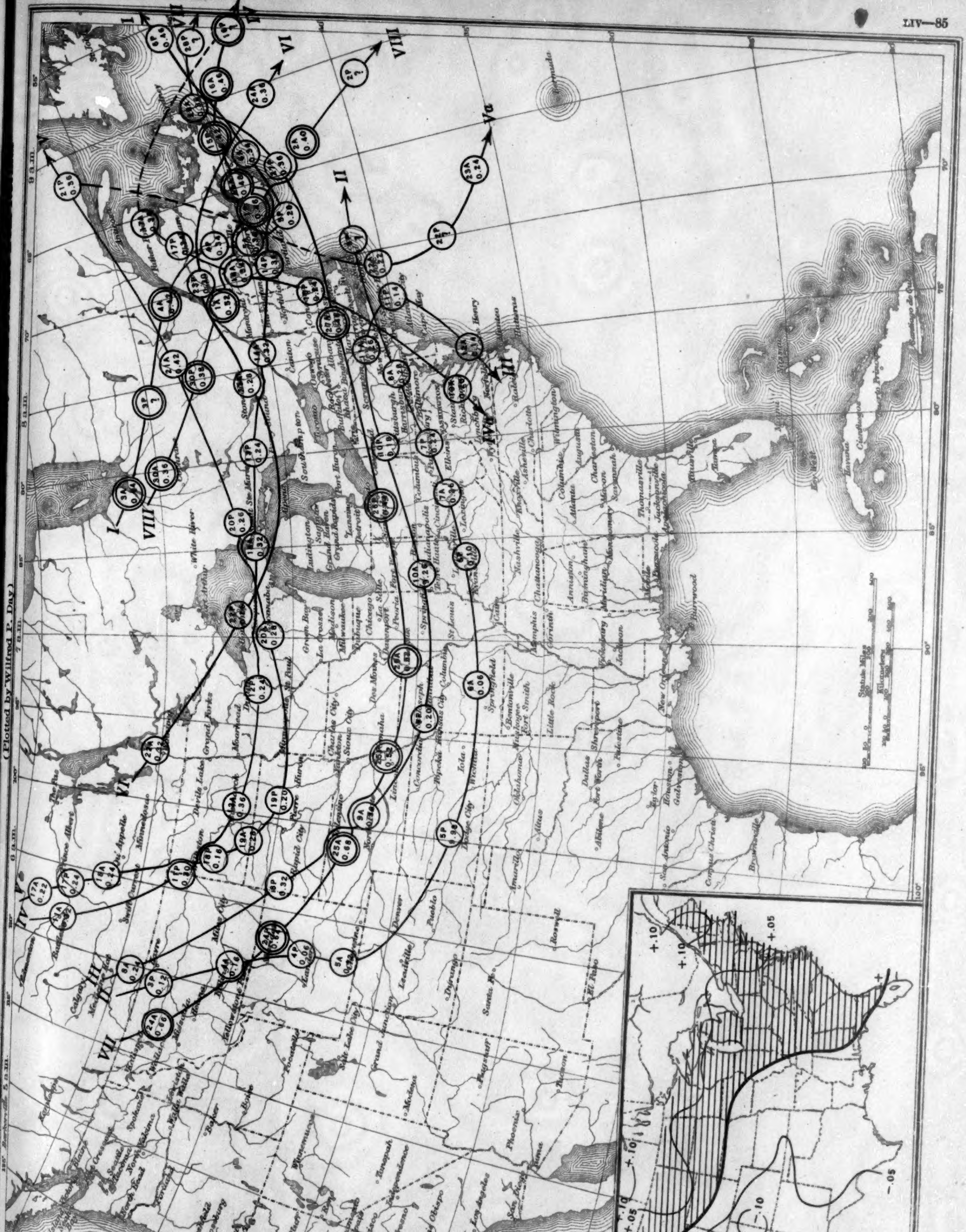

(Plotted by Wilfred P. Day)

Chart II. Tracks of Centers of Cyclones, September, 1926. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)

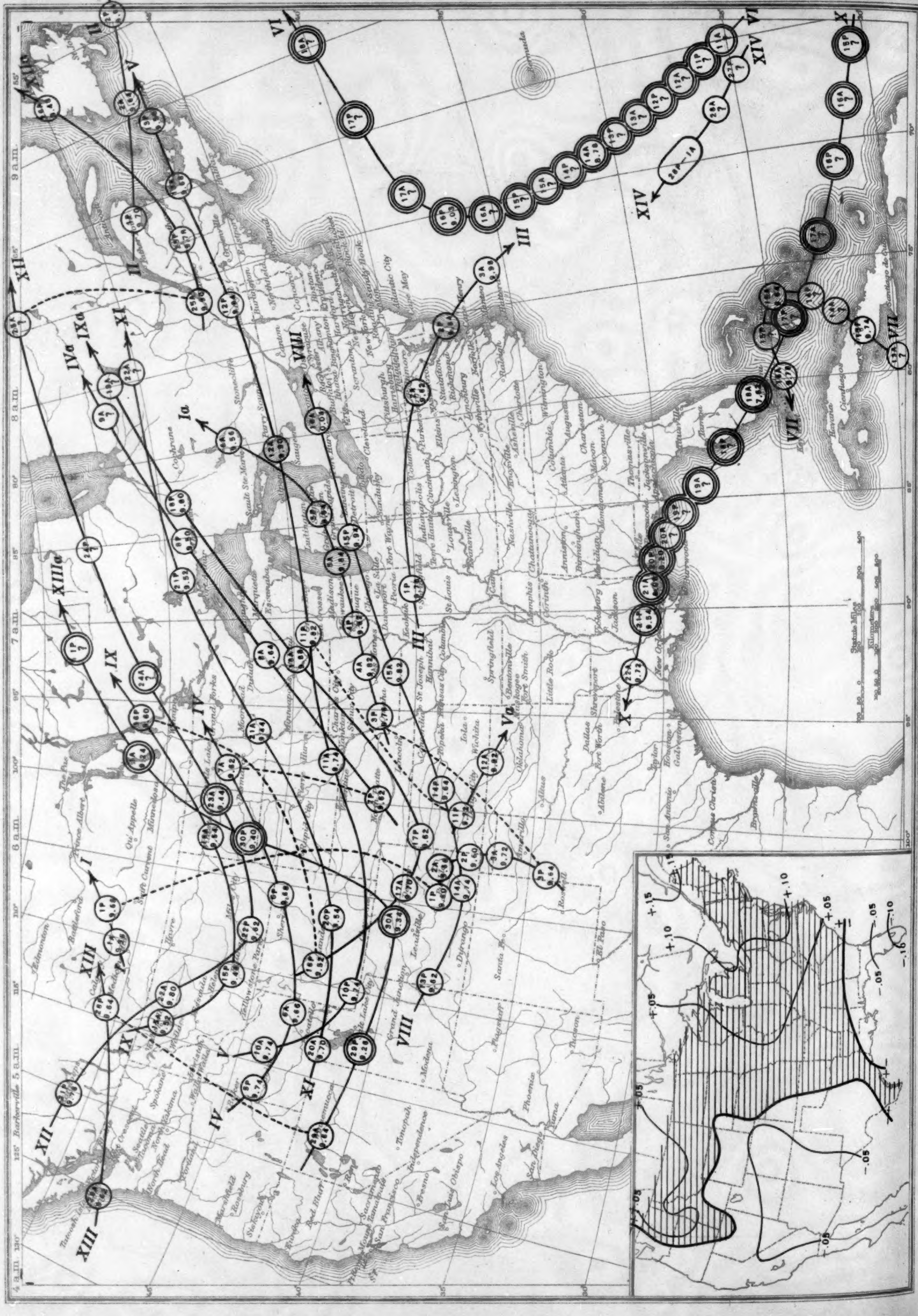
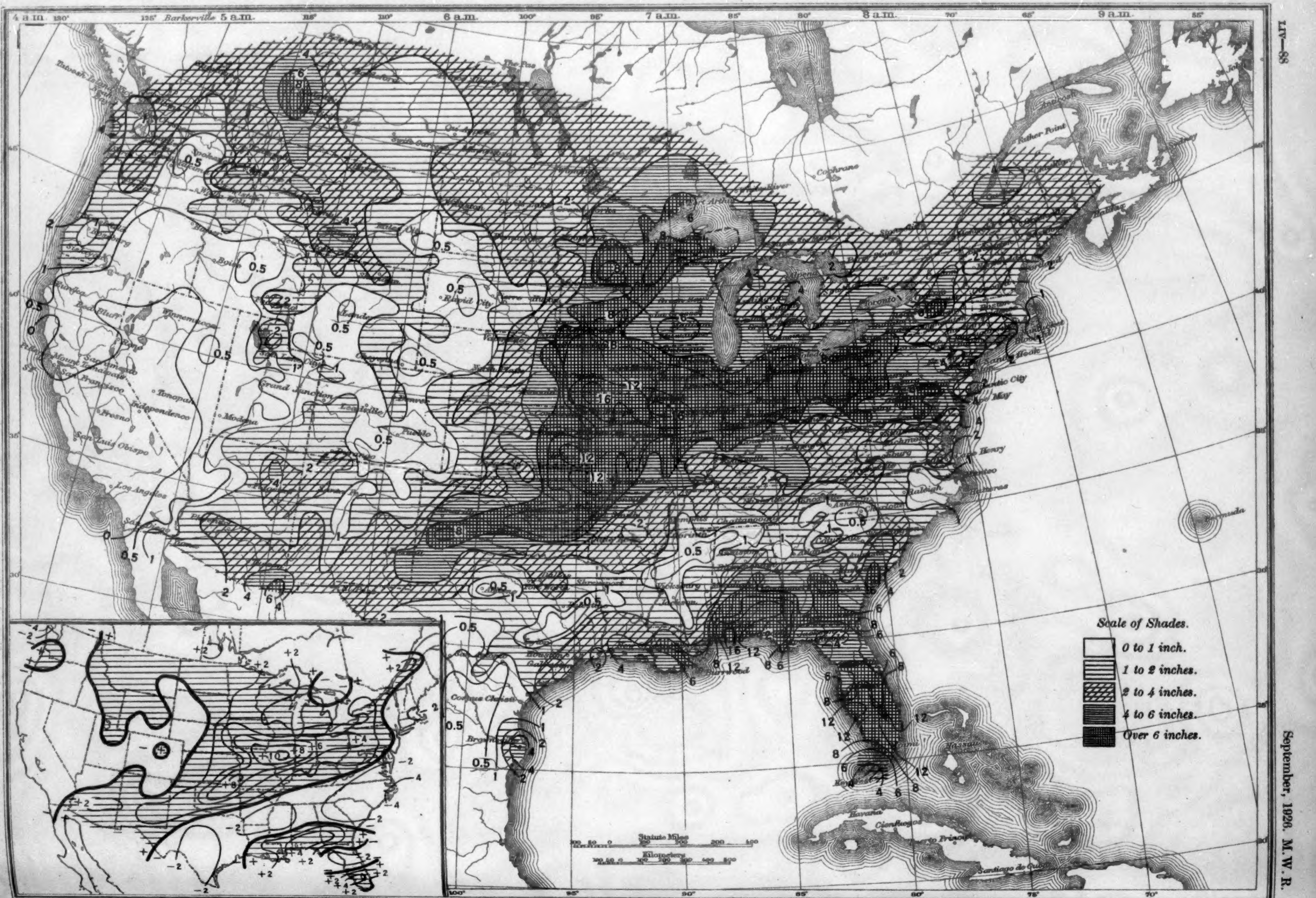


Chart III. Departure (°F.) of the Mean Temperature from the Normal, September, 1926

Shaded portions show excess (+). Unshaded portions show deficiency (−). Lines show amount of excess or deficiency.

Chart IV. Total Precipitation, Inches, September, 1926. (Inset) Departure of Precipitation from Normal



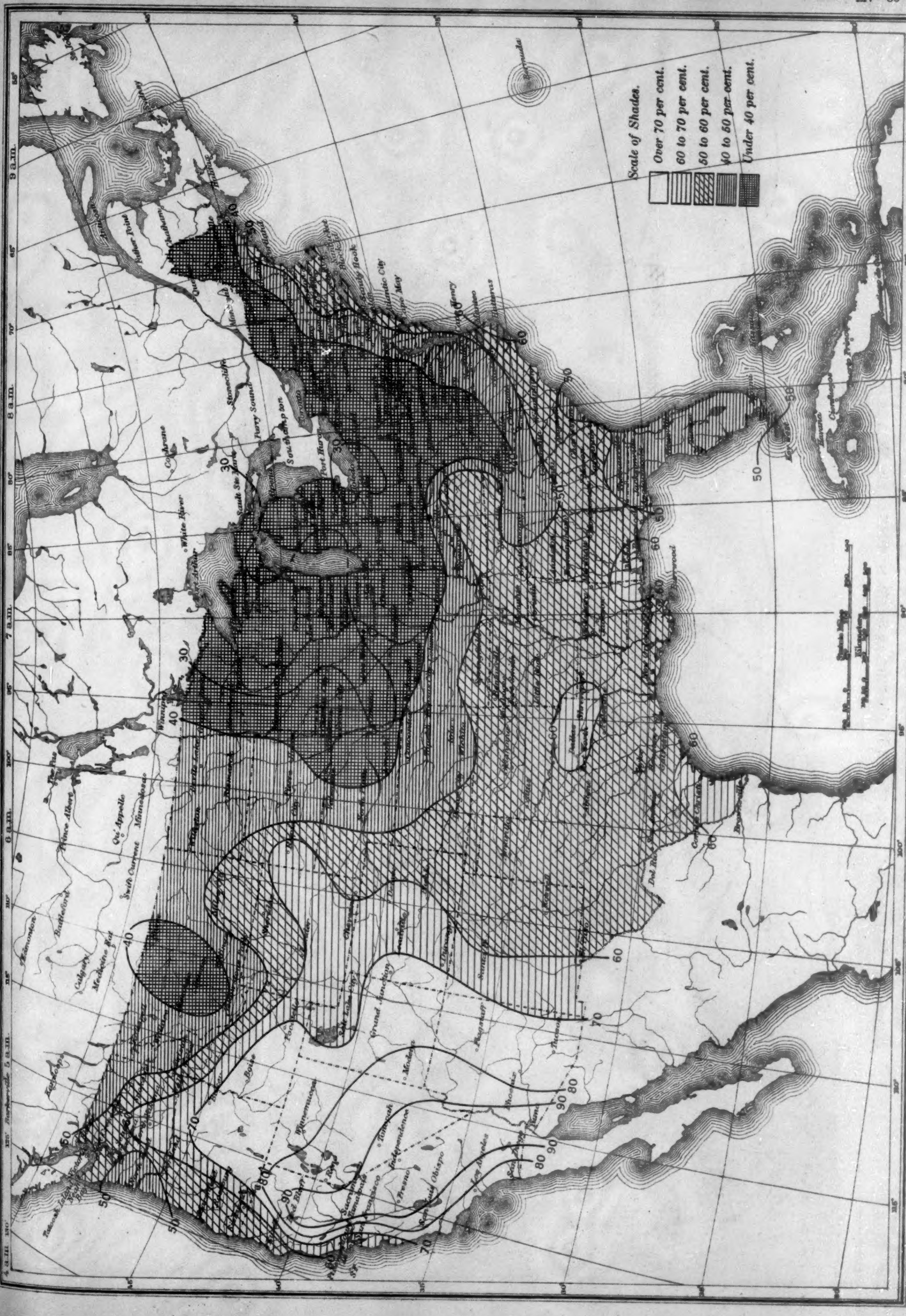
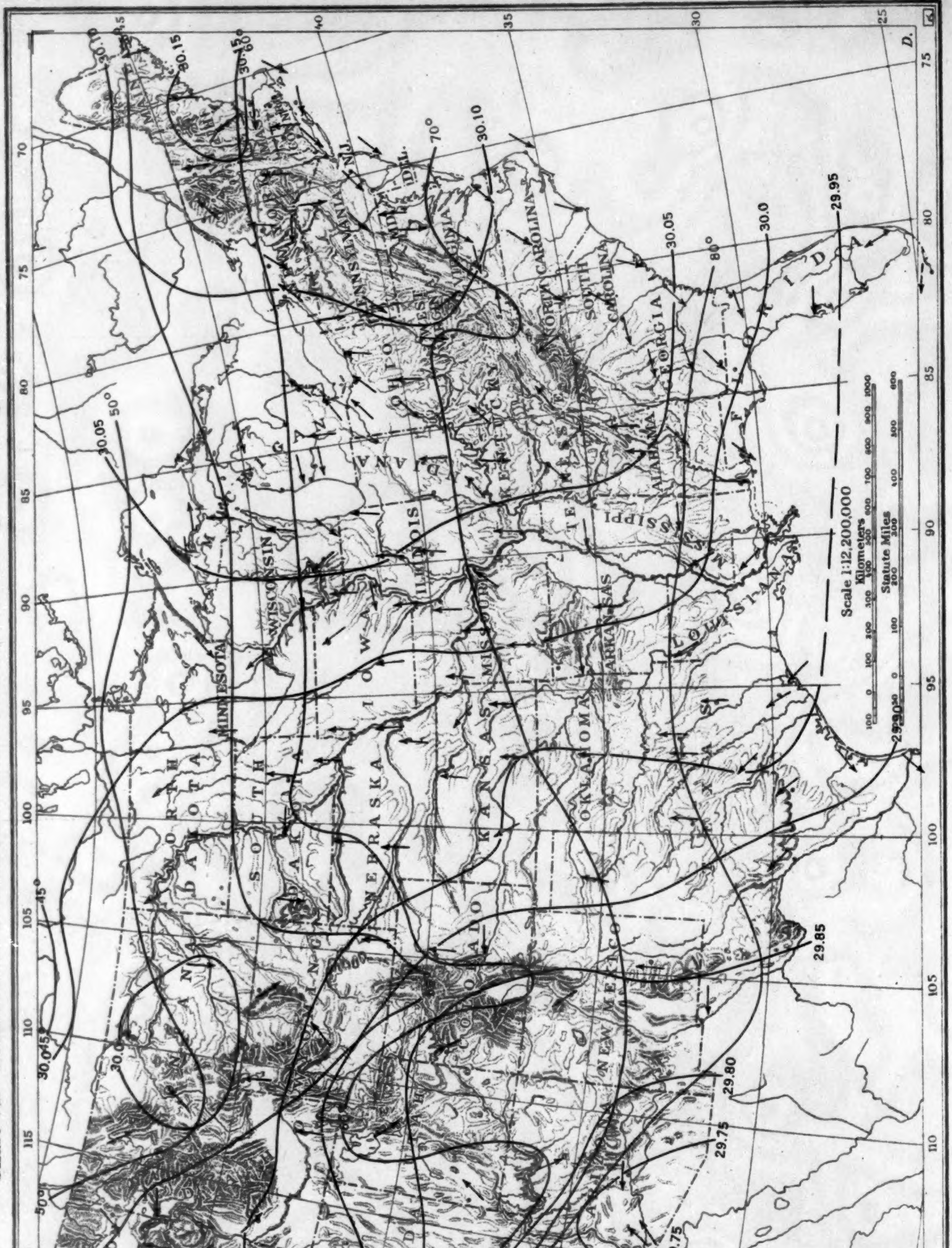


Chart V. Percentage of Clear Sky between Sunrise and Sunset, September, 1926

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, September, 1926



(Plotted by F. A. Young)

(Plotted by F. A. Young)

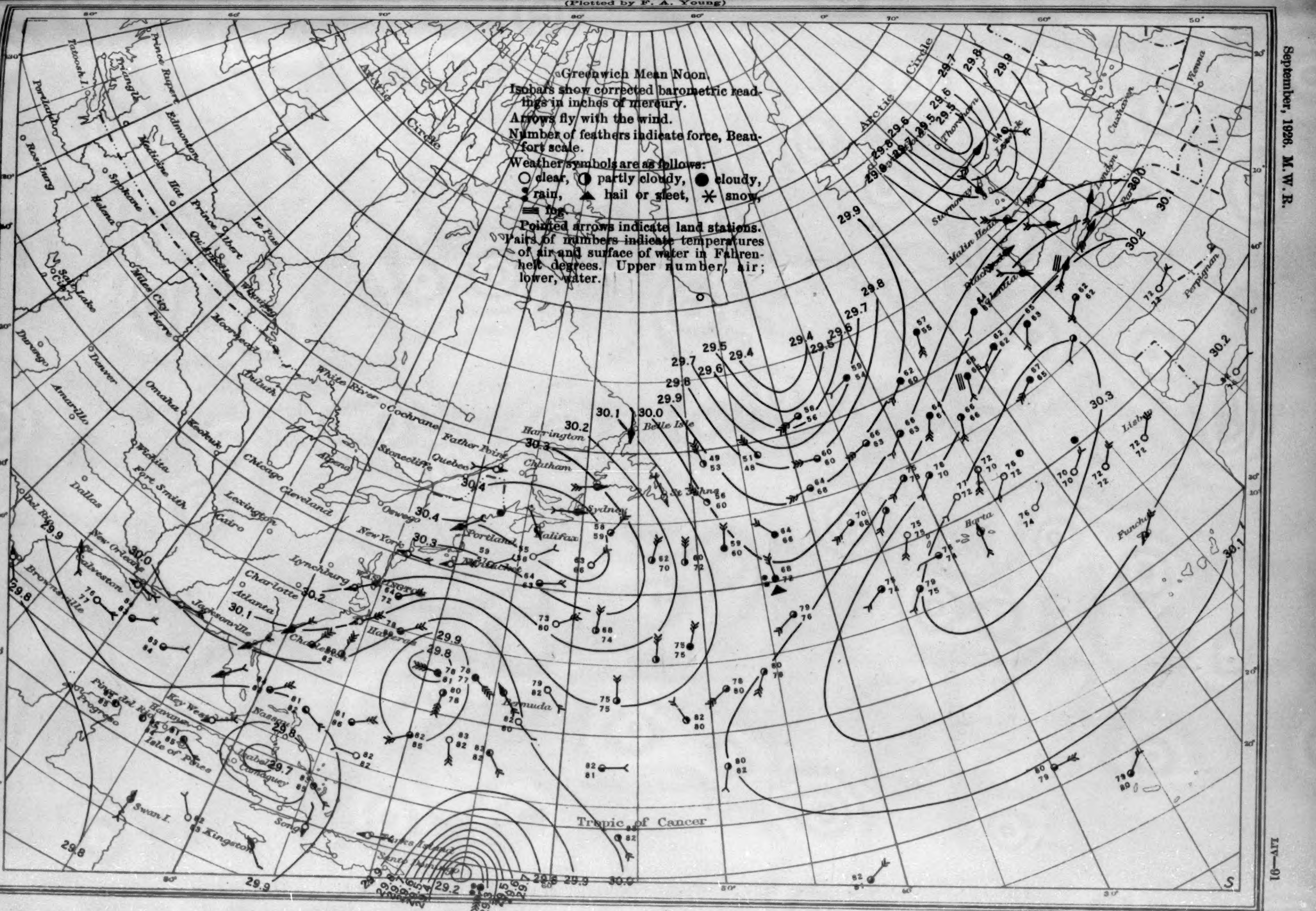
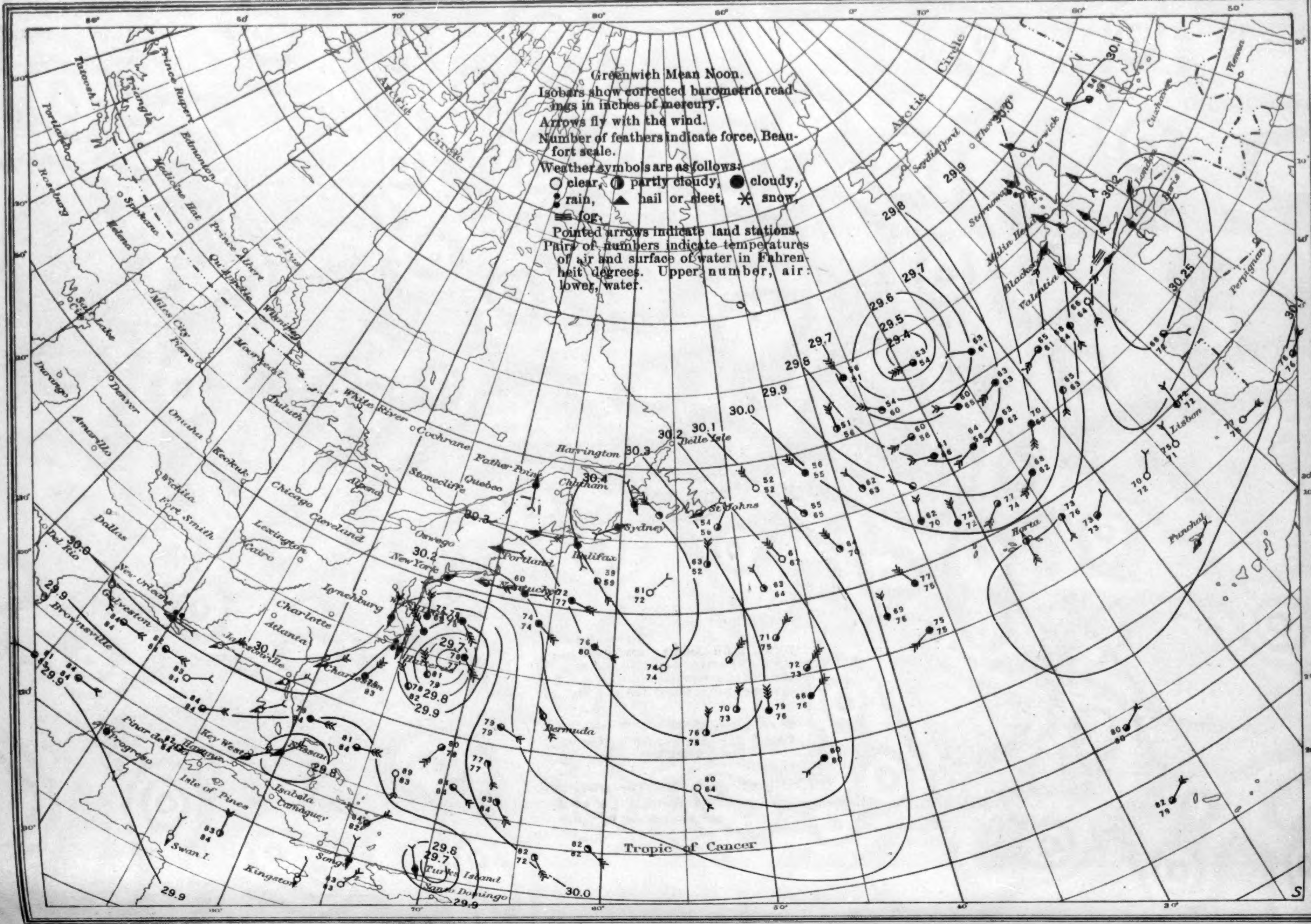


Chart IX. Weather Map of North Atlantic Ocean, September 16, 1926

(Plotted by F. A. Young)



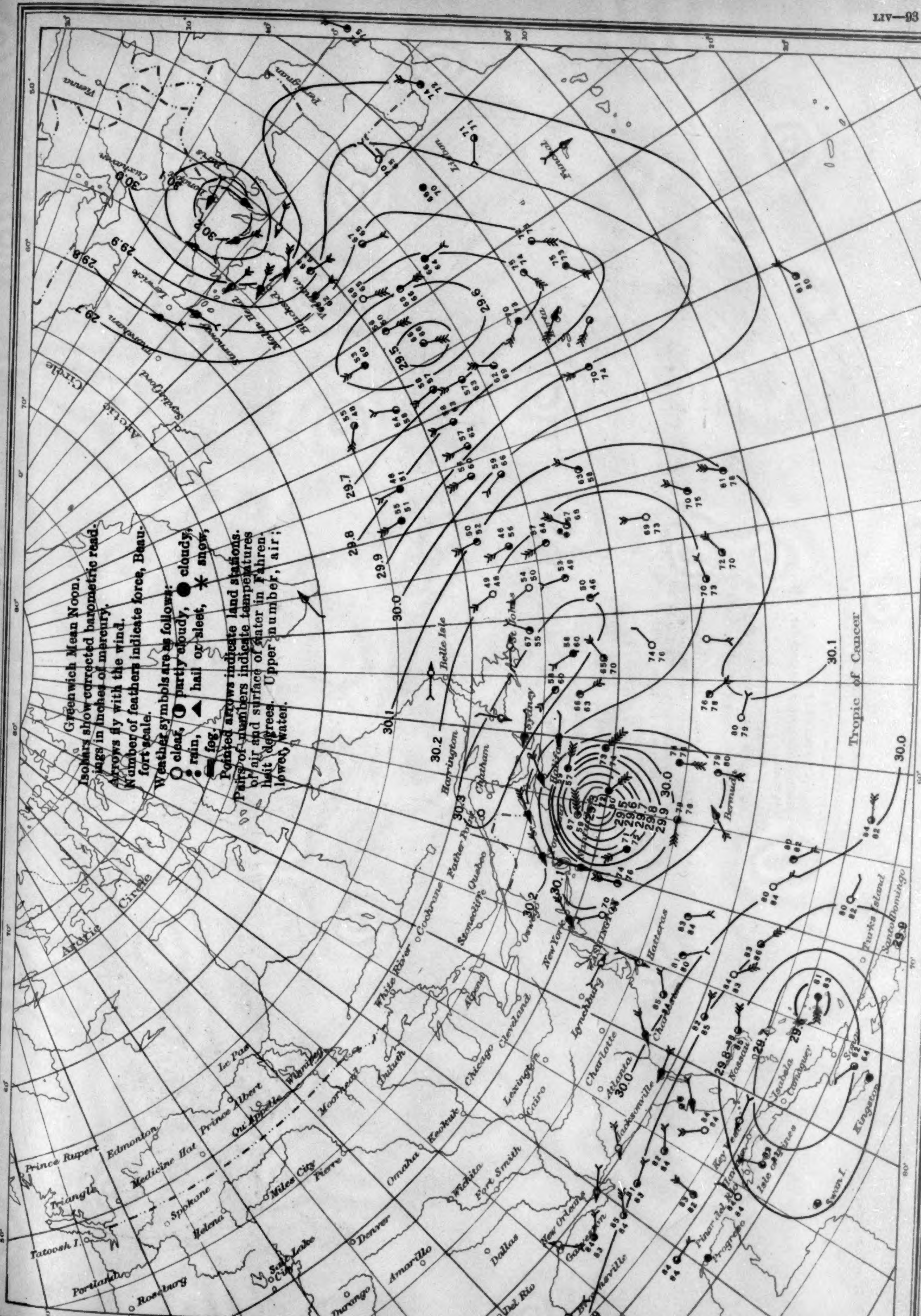


Chart X. Weather Map of North Atlantic Ocean, September 17, 1926
(Plotted by F. A. Young)

Chart XI. Weather Map of North Atlantic Ocean, September 18, 1926

(Plotted by F. A. Young)

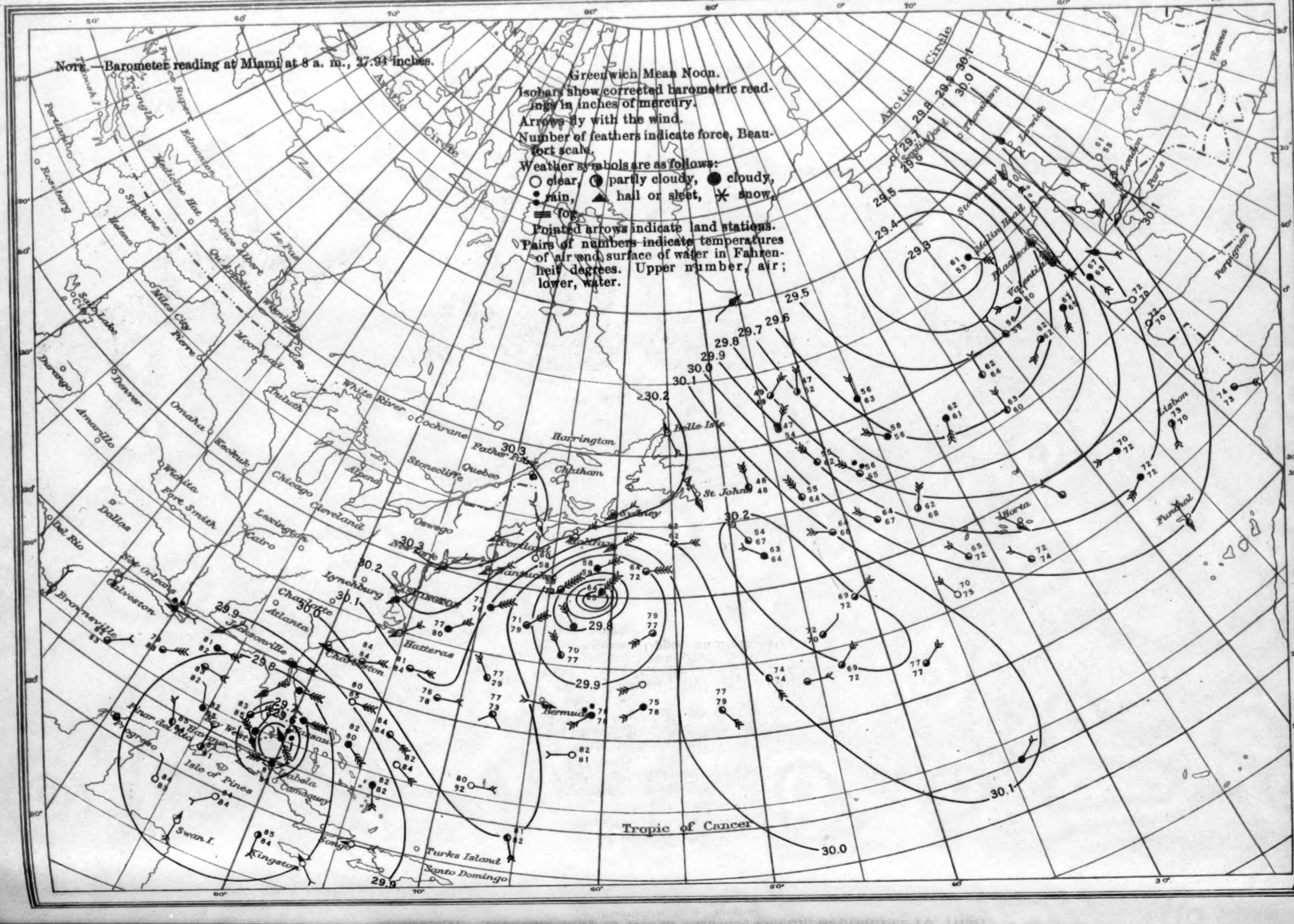


Chart XII. Weather Map of North Atlantic Ocean, September 19, 1926
(Plotted by F. A. Young)

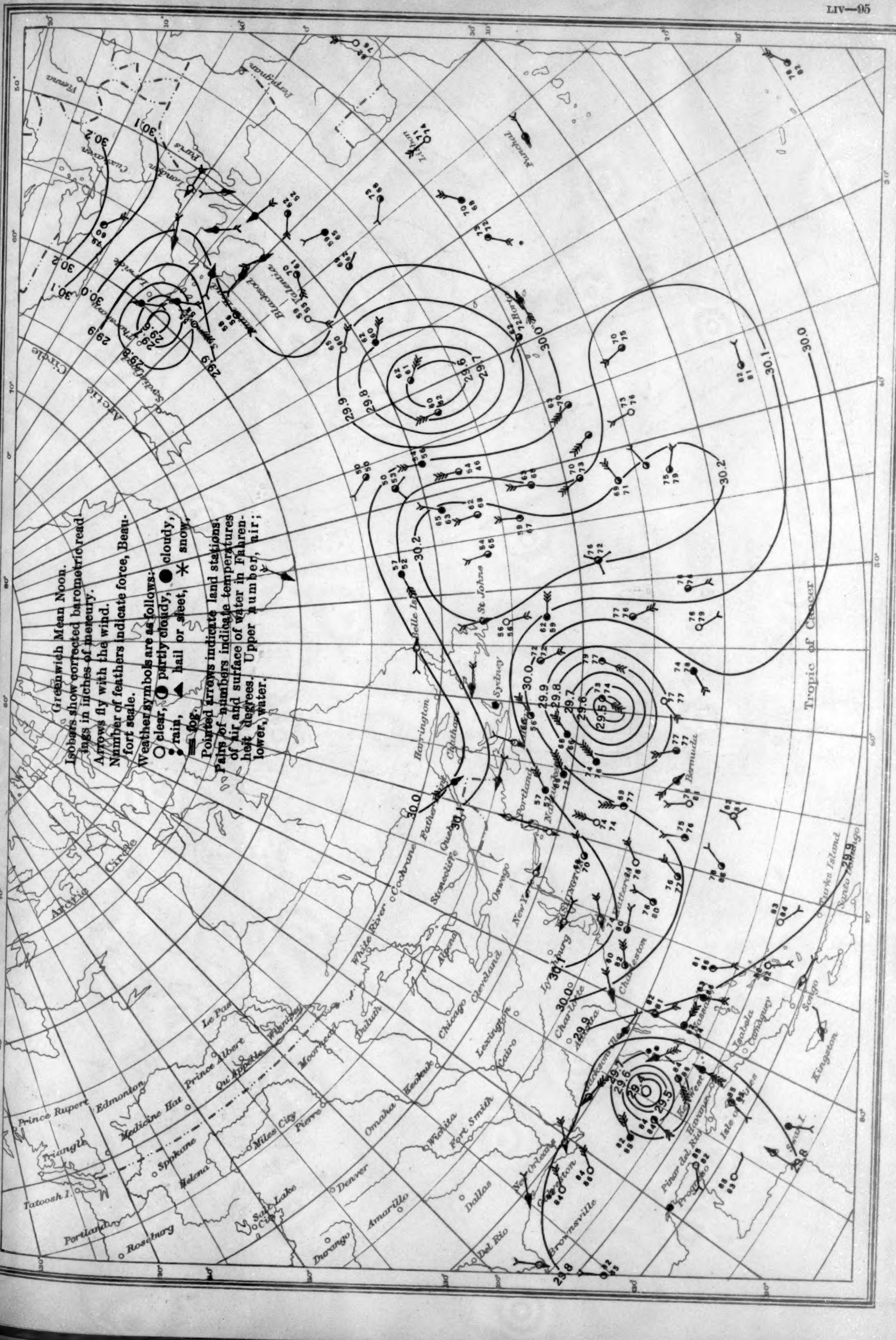


Chart XIII. Weather Map of North Atlantic Ocean, September 20, 1926
(Plotted by F. A. Young)

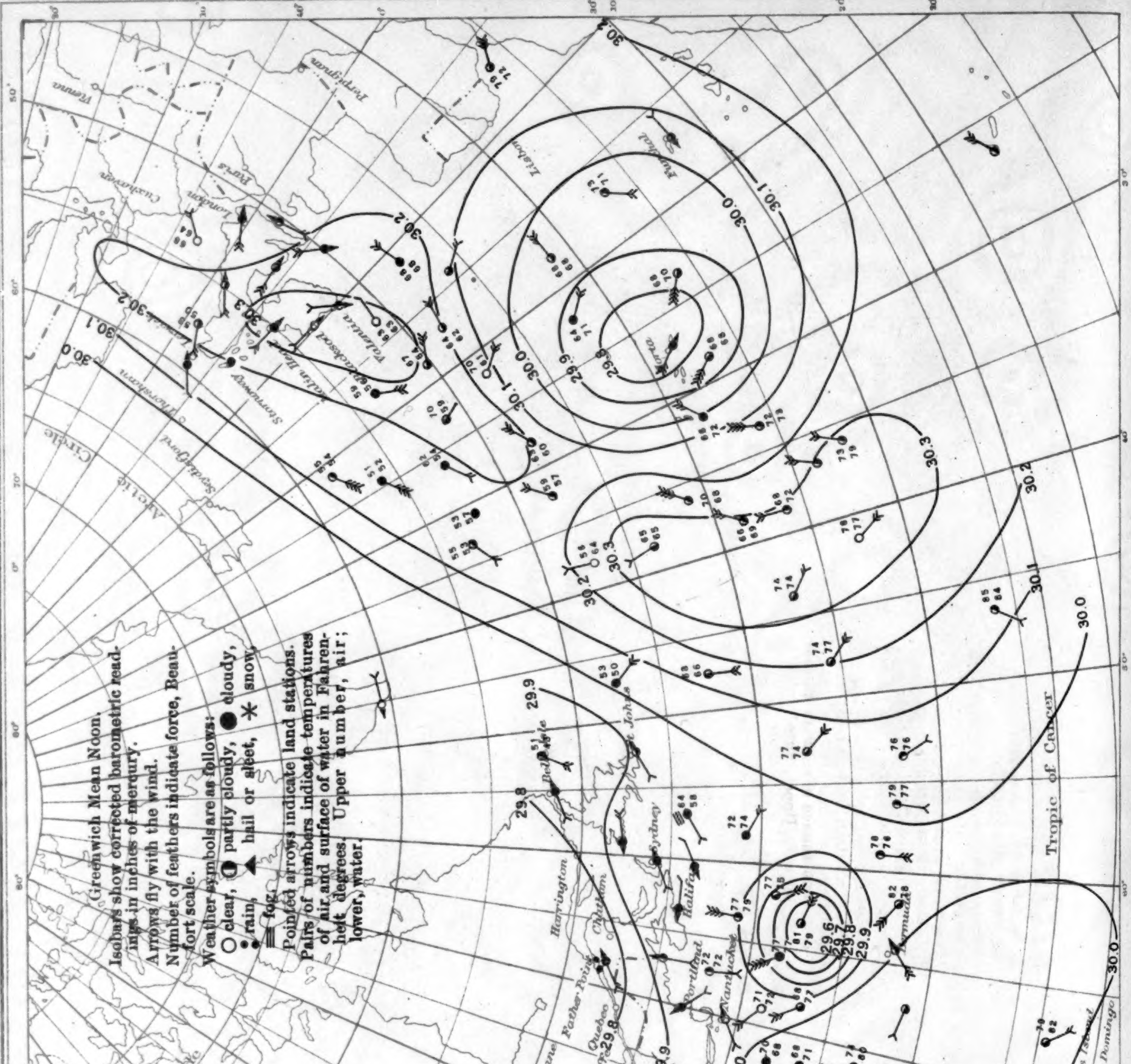


Chart XIV. Weather Map of North Atlantic Ocean, September 21, 1926
(Plotted by F. A. Young)

Chart XIV. Weather Map of North Atlantic Ocean, September 21, 1926
(Plotted by F. A. Young)

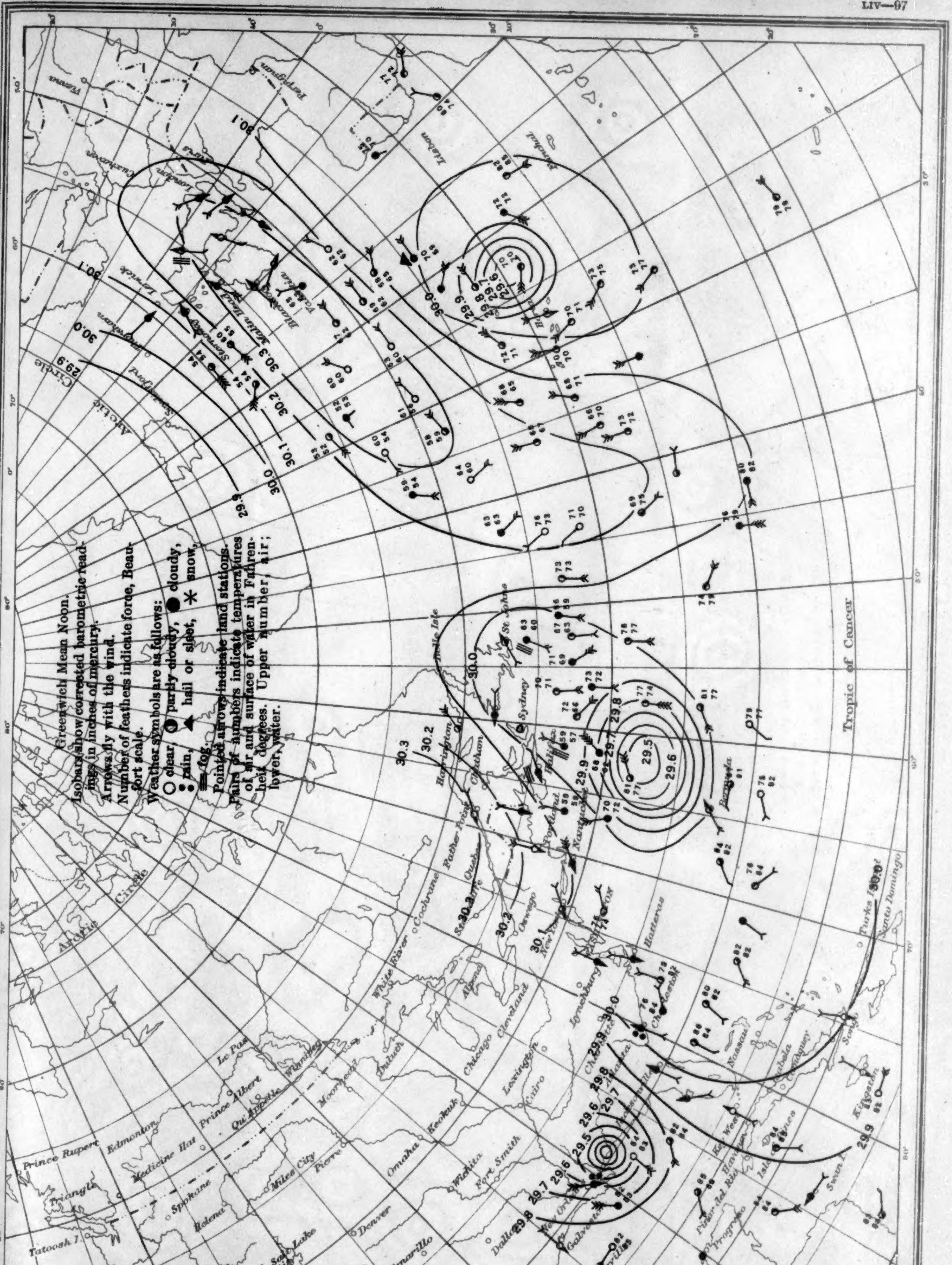
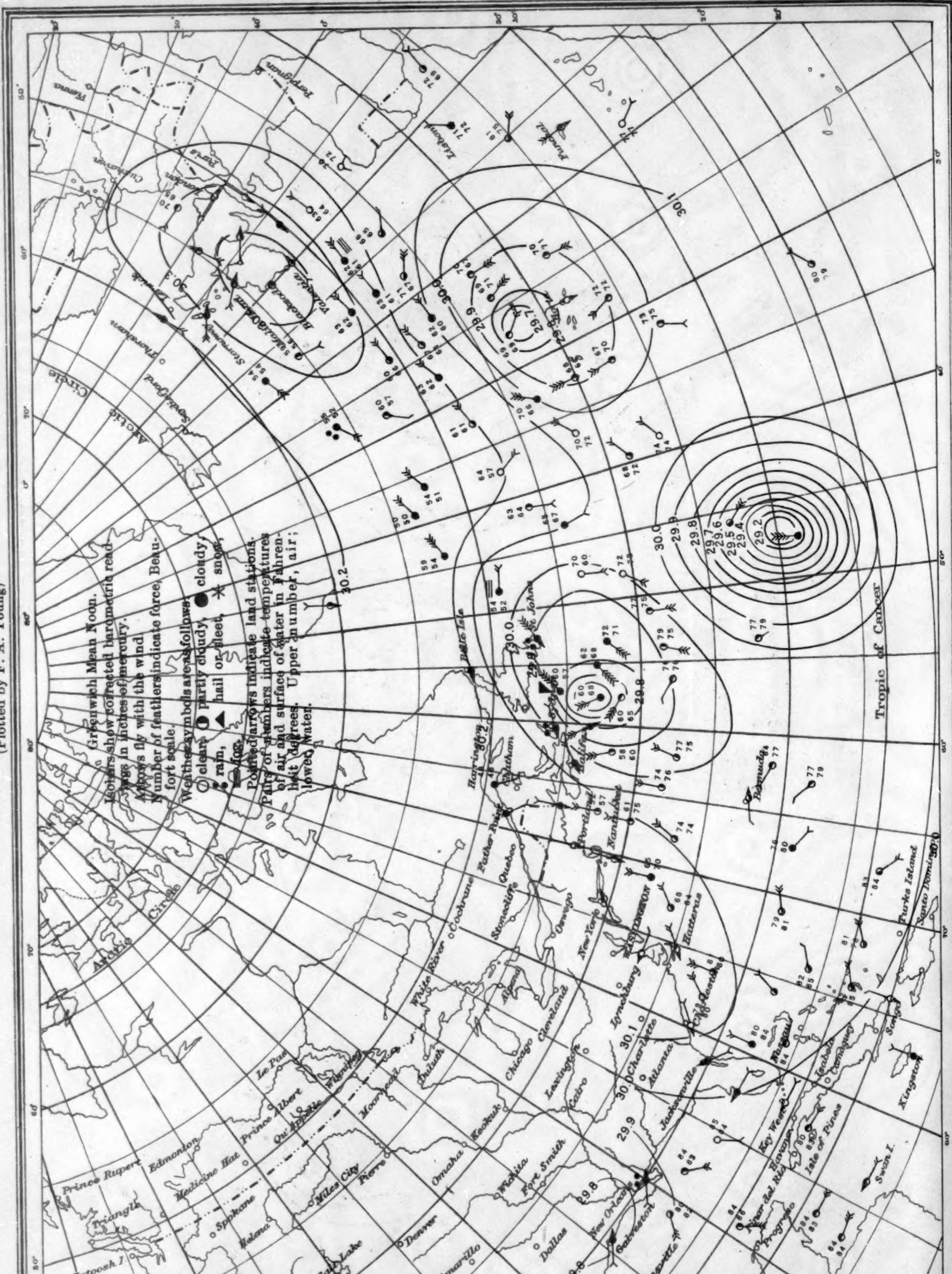


Chart XV. Weather Map of North Atlantic Ocean, September 22, 1926
(Plotted by F. A. Young)



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